# Accelerating zero-emission building sector ambitions in the MENA region (BUILD_ME)

## Report on activities in Egypt from the first project phase of BUILD_ME (2016 – 2018)

**Prepared on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety under the International Climate Initiative**


***Submitted by:***
Navigant Energy Germany GmbH
Albrechtsstr. 10c
10117 Berlin

T +49 30 7262 1410
guidehouse.com


***in cooperation with IDG and HBRC***


Authors: Sven Schimschar, Jonas Schröder, Riadh Bhar, Farid Comaty, Carsten Petersdorff, Alexander Pohl, Moritz Schäfer, Karoline Steinbacher



Navigant reference no.: 206596
22 April 2020





Supported by:
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
INTERNATIONALE KLIMASCHUTZINITIATIVE (IKI)

## TABLE OF CONTENTS

# DISCLAIMER

This report was prepared by Navigant Consulting, Inc., n/k/a Guidehouse Inc. ("Navigant"),[1] on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety under the International Climate Initiative. The work presented in this report represents Navigant's professional judgment based on the information available at the time this report was prepared. Navigant is not responsible for the reader's use of, or reliance upon, the report, nor any decisions based on the report. NAVIGANT MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

This report summarizes the results of the first phase of this project from 2016 to 2018. Any developments after this date are not reflected in this report. Also, some of the results presented in this report reflect the views of individuals interviewed in the course of the project and may therefore not reflect the position of Navigant, it's partners or the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

[1] On October 11, 2019, Guidehouse LLP completed its previously announced acquisition of Navigant Consulting Inc. In the months ahead, we will be working to integrate the Guidehouse and Navigant businesses. In furtherance of that effort, we recently renamed Navigant Consulting Inc. as Guidehouse Inc.

# 1. INTRODUCTION

This report presents the results of the Egyptian part of the project “Accelerating zero-emission building sector ambitions in the MENA region”, funded by the German Federal Ministry for the Environment and carried out by Navigant, a Guidehouse Company, (formerly Ecofys[2]) together with local partners.

Despite its natural resource reserves, Egypt increasingly had to rely on imports over the past years to meet the ever-growing demand of energy due to a growing population, increasing urbanisation and rising standards of living. In order to provide affordable energy services to low-income households, Egypt’s energy sector has been heavily subsidised. Budgetary problems and growing deficits placed a heavy burden on the economy as a whole, giving energy efficiency (EE) and renewable energy sources (RES) political traction. Recognition of the potential of EE in the building sector resulted in the adoption of mandatory regulations for EE between 2006 – 2011, including mandatory energy efficiency codes in buildings and minimum energy performance standards for electrical appliances. Another important area of political action was the incremental reform of energy subsidies on gasoline, diesel and natural gas in 2014.

After the project analysed this background (see chapter 2), it conducted an extensive dialogue with the most relevant stakeholder groups in the Egyptian building sector (e.g. public authorities, project developers, banks or consumers). The goal of the stakeholder dialogue was to identify drivers and barriers for the uptake of EE and RES in the residential building sector. Main barriers that were identified included a lack of financial support regarding high upfront investments and missing incentives as well as standards to attract people to install energy efficient systems (chapter 3.2).

In parallel, two pilot projects in Cairo (Porto Pyramids) and North Egypt (Upscale Nabta Town) were selected in the framework of this project to establish an exchange between policy dialogue and practical aspects in the construction sector. For both projects technical measures including the building envelope, appliances and solar energy were evaluated as well as a set of the most economical and impactful measures to form holistic packages. The Porto Pyramids project and the Nabta project continue to evaluate the implementation of proposed measures (chapter 3.3).

In a next step, potential policy measures to promote EE and RES in buildings in Egypt were discussed with stakeholder groups. Many of the recommendations aimed at building capacities and awareness at municipalities, project developers, banks and utilities (chapter 4.1). Based on these insights, potential political measures were evaluated using integrated modelling. In order to prioritize the implementations of policy recommendations in Egypt, an impact assessment was carried out to analyse the energy saving potential, $CO_2$ reduction, necessary investments and job effects in comparison to the business-as-usual scenario (chapter 4.2).

[2] Please note that Ecofys Germany GmbH changed its name per 1 January 2019 to Navigant Energy Germany GmbH. Therefore, the current report is prepared under the name of Navigant Energy Germany GmbH.

# 2. STARTING SITUATION 2016

## 2.1 Key Macro-Economic Indicators

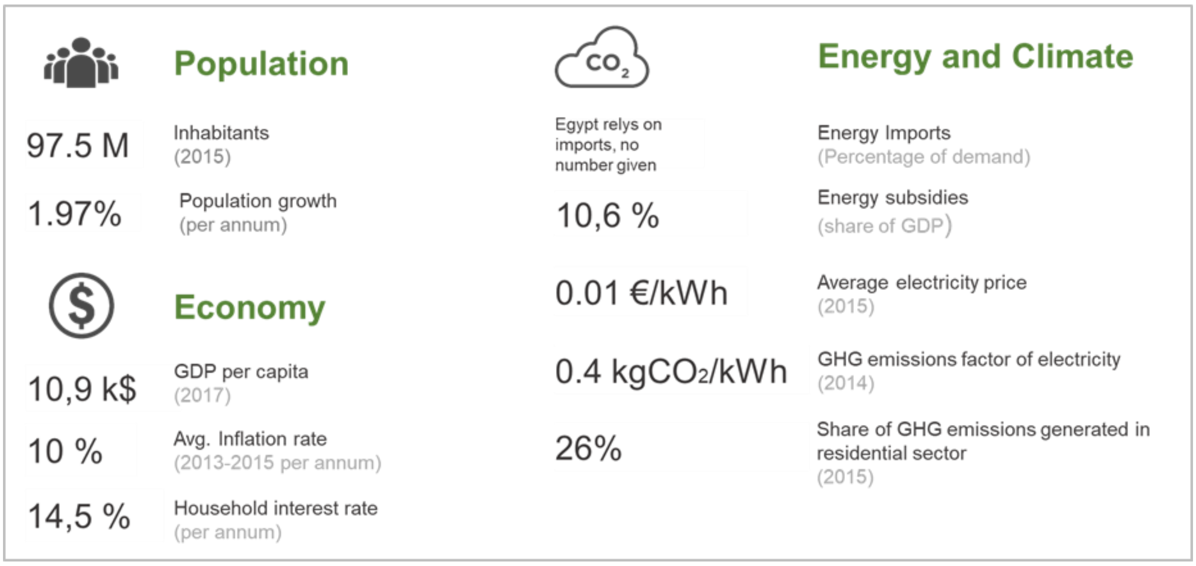



**Figure 1: Key macro-economic indicators of Egypt**

With a population of more than 97 million inhabitants, Egypt is a regional power in the MENA region. Despite its natural resource reserves – oil and gas – the country increasingly has to rely on imports to meet ever growing demand. Egypt also faces energy challenges related to a growing population, increasing urbanisation and rising standards of living. Due to budgetary problems and growing deficits, the IMF and Egypt have agreed on a USD 12bn (~EUR 12.9bn) loan in 2015 that also requires reforms in the energy sector, in particular reducing the very high subsidies on fossil fuels for energy intensive industries as well as for electricity. Due to existing subsidies on energy, the energy prices are extremely low in Egypt. Local experts expect the removal of the subsidies in 2022.

The financial framework conditions for energy efficiency investments in the Egyptian context provide a mixed picture. The GDP per capita (PPP) of USD 10,900 at purchasing power parity is low in regional comparison. The combination of a high inflation rate (~10%) and high interest rates (~14.5%) decreases the attractiveness of energy efficiency investments. Egypt subsidizes energy consumption to a very high extent (about 10.6% of its national GDP), resulting in extremely low electricity prices of an average of currently EGP 0.39/kWh (about EUR 0.01/kWh) as well as low fossil fuel prices, including for energy-intensive industries. There is off-peak/peak-differentiated electricity pricing in place for medium, high, and extra-high voltage level costumers.

Consumers at lower levels of electricity consumption are entitled to even lower prices. However, Egypt has launched a five-year plan to completely eliminate electricity subsidies by 2019 in July 2014.

Egypt currently has comparatively good levels of security of supply with electricity provided in 96% of hours on average. However, stress on the electricity sector is increasing – also as a consequence of biased investment choices in energy intensive industries due to the high subsidies for energy policy. The country's electricity emission factor was 443.76g $CO_2$/kWh in 2014. However, generation is still mainly based on gas and petroleum. Additional investments are needed to reach the country's 20% renewable goal by 2020.

## 2.2 Starting Situation in the Building Stock

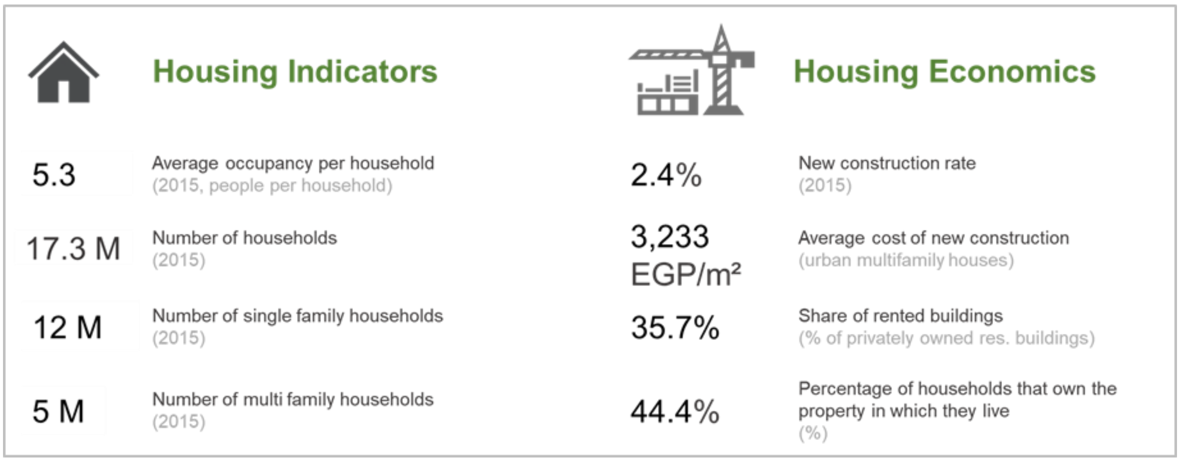



**Figure 2: Key statistics on Egypt's building stock**

There are 17.3 million households in Egypt with an average occupancy of 5.3 persons per household. Almost 12 million households are single family households and 5 million households are multifamily households. Construction costs for urban multifamily homes vary from EGP 1,500 per $m^2$ (low-class project) to EGP 5,000 per $m^2$ (high-class project) with average costs amounting to EGP 3,233 per $m^2$. 35,7% of privately-owned residential buildings are rented out, on the other hand 44,4% of households own the property that they live in.

## 2.3 Current State in Cooling and Heating Technologies

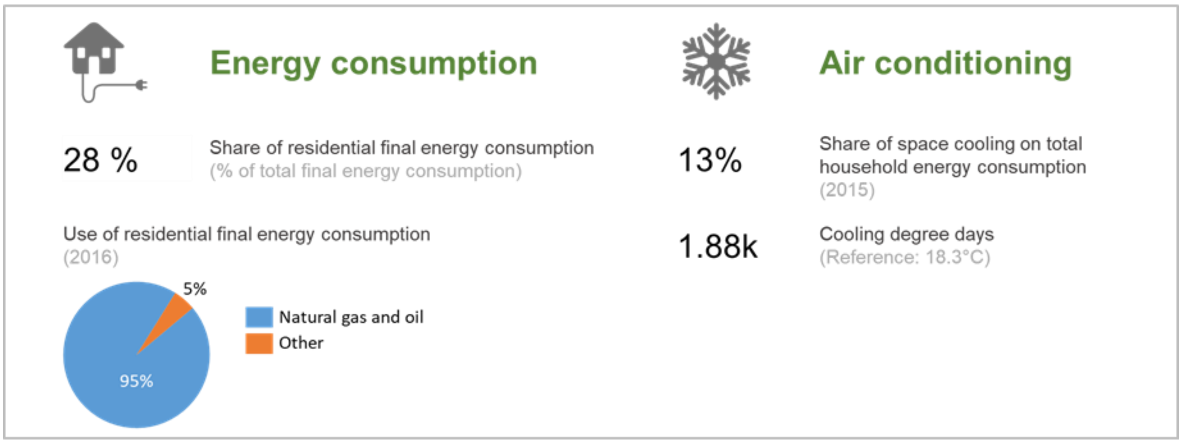



**Figure 3: Key metrics of heating and cooling in residential buildings in Egypt**

About 28% of final energy consumption in Egypt is in the building sector (including residential, non-residential and public buildings) (IEA, 2017). The largest share of which (22%) is consumed in residential buildings. As more than 95% of primary energy needs are covered by natural gas and oil (IEA, 2017), this leads to high emissions both in absolute terms and in the buildings sector. Accordingly, 26% of GHG emissions are generated in the residential sector. Energy demand in the building sector will continue to grow, especially through heating and cooling in non-residential buildings. Space heating and cooling each account for about 13% of household energy consumption, while hot water production is responsible for about 11% (World Bank, 2017). This is expected to change with rising living standards and a wider distribution of space cooling equipment. For cooling, people in new multi-family house constructions usually use fans and AC split units, both of which are powered by electricity. The common technique for heating apartment buildings in Egypt is electric heating, while solar thermal hot water generators (flat plate with storage tank) are traditionally used to provide hot water.

## 2.4 Existing Policy Framework for Building Efficiency

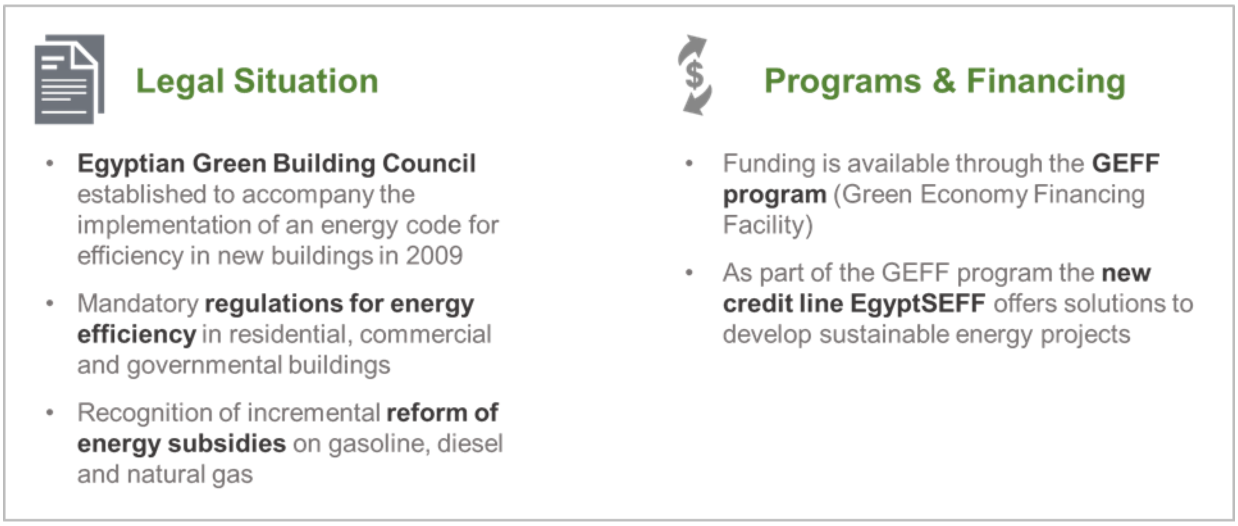



**Figure 4: Existing Policy Framework in Egypt**

**Legal Situation**

Egypt has adopted a National Energy Efficiency Action Plan for 2012-2015 which foresaw a 5% energy efficiency gain. However, the regulatory framework for energy efficiency in Egypt remains relatively weak, in particular with regard to enforcement. In January 2009, the Egyptian Green Building Council (Egypt-GBC) was established to accompany the implementation of an energy code for efficiency in new buildings. Qualitative assessments of local project partners indicate a solid level of awareness for energy efficiency concerns, but an almost complete lack of industry participation in the design and implementation of building standards.

Recognition of the potential of energy efficiency in the building sector has led to the adoption of mandatory regulations for energy efficiency. These include a mandatory energy efficiency code for residential buildings (2006), an energy efficiency code for commercial buildings (2009), and an energy efficiency code for governmental buildings (2011). Minimum energy performance standards with mandatory labelling schemes have been adopted for air conditioners, refrigerators, freezers, washing machines, compact fluorescent lamps (CFLs), and electric water heaters. However, implementation is lagging, and the concrete impact of these measures is therefore not yet visible.

Another important area of political action is the incremental reform of energy subsidies on gasoline, diesel and natural gas. As RCREEE (2015) notes, additional effort is needed regarding strengthening and improving the available institutional capacities with a particular focus on implementation and enforcement.

**Programs and Financing**

EgyptSEFF (Egypt Sustainable Energy Financing Facility) is a new credit line that was initiated in 2016 to be dedicated to energy efficiency and renewable energy investments in Egypt. It offers an inclusive solution to develop the sustainable energy projects of Egypt. This credit line was developed by EBRD (European Bank for Reconstruction and Development) as part of the GEFF program (Green Economy Financing Facility).

GEFF Egypt (formerly EgyptSEFF- Egypt Sustainable Energy Financing Facility) is a comprehensive financing facility programme with an amount of up to €140 million for sustainable energy investments. It focuses on promoting the energy efficient and renewable energy technologies in Egypt by raising awareness of the benefits of investments in such technologies, thus increasing the demand. The program is a product of the European Bank for Reconstruction and Development (EBRD) and works in cooperation with the Agence Française de Développement (AFD) and the European Investment Bank (EIB). The funds provided by this facility will reach the private sector borrowers through the participating financial institutions (banks). In Egypt, a number of banks are participating in the GEFF program including: QNB bank, Al Ahli bank, NBK bank and AlexBank. The project covers a loan to AlexBank of up to USD 30 million which is co-financed by the (EIB). QNB's share is USD 40 million while NBK gets USD 30 million.

The following entities are eligible to apply for these loans: Private legal entities, individual entrepreneurs or companies investing in EE and/or RE projects in Egypt. These include small, medium and large enterprises (SMEs and LEs), suppliers, manufacturers and installers of Renewable Energy and Energy Efficient equipment.

# 3. KEY FINDINGS OF THE PROJECT

## 3.1 Most Relevant Stakeholder Groups and Institutions

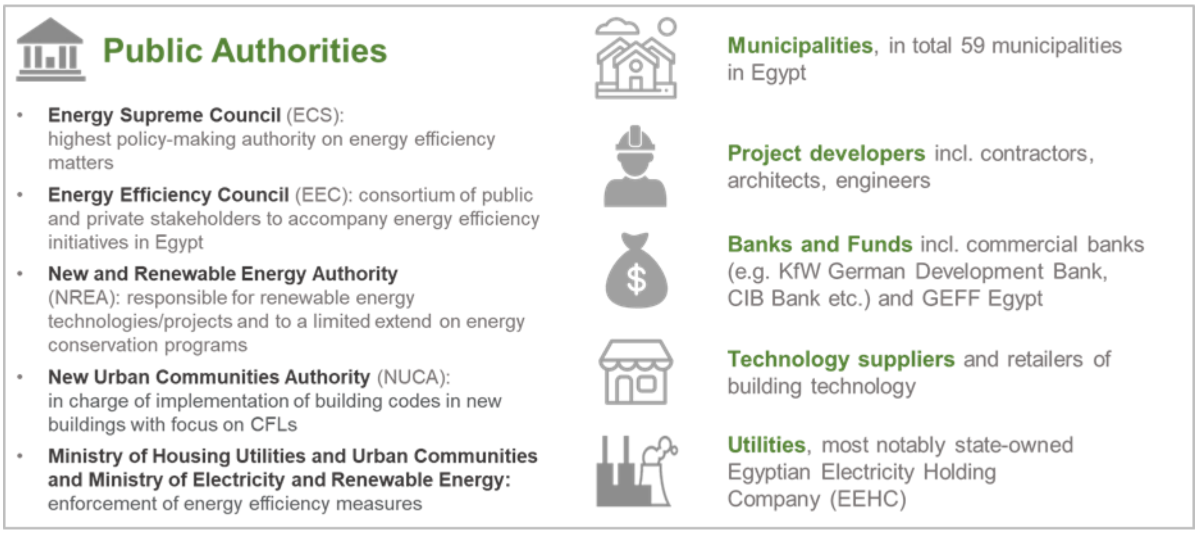



**Figure 5: Non-exhaustive list of most relevant stakeholders in the Egyptian buildings sector**

### *3.1.1 Public stakeholders*

#### *3.1.1.1 Ministries and Government Agencies*

In terms of the institutional setup, the Energy Supreme Council (ESC, est. in 1979) is the highest policy-making authority on energy efficiency matters. It brings together representatives from eleven ministries under the chairmanship of the Prime Minister. It is currently focusing on the dissemination of energy efficiency concepts in the following sectors: residential sector, street lighting, governmental buildings and public utilities. The development of energy strategies and guidance regarding energy reform measures fall under its competency. Within the ESC, an Energy Efficiency Unit was created in 2009. The unit coordinates all activities concerning policy implementation for energy efficiency. It also provides technical assistance, develops market initiatives and brings together staff from different ministries. Created in 2000, the Energy Efficiency Council (EEC) is a consortium of public and private stakeholders and accompanies energy efficiency initiatives in Egypt. Another central institution that is affiliated to the Ministry of Electricity and Renewable Energy is the New and Renewable Energy Authority (NREA). Established in 1986, it focuses on renewable energy technologies/projects and to a limited extend also on energy conservation programs. Despite the large number of authorities and organizations involved in the Energy sector in Egypt, still there is no clear framework connecting these different bodies.

As part of efforts to institutionalize energy efficiency, Energy Efficiency Units (EEUs) have been set up in different ministries in addition to a cross-cutting unit. The New Urban Communities Authority (NUCA) is charged with implementing the building codes in new buildings, with a focus on CFLs. An important step was taken in 2015 when the Ministry of Housing Utilities and Urban Communities and the Ministry of Electricity and Renewable Energy signed a memorandum of understanding to cooperate on the enforcement of energy efficiency measures. However, obstacles to implementation persist due to ineffective regulatory frameworks on municipal level, a lack of monitoring and verification enforcement as well as the absence of an incentive scheme for residents and developers.

### *3.1.1.2 Municipalities*

There are 59 municipalities in Egypt with Kairo, Alexandria, Sues and al-Mansura in the Nile Delta representing a third of Egypt's Population.

From the interview results, the responsibility of granting permits for buildings is on the municipalities. Several interviews have been conducted with the municipality Giza - Egypt. Giza Governorate has instructions and decisions from the ministries to use devices that reduce energy consumption and emissions, especially PV systems, solar water heaters and LED lamps. These decisions should be achieved by improving the energy efficiency for the governmental buildings in the municipality such as administrative buildings, schools, mosques, churches and gardens, etc. There are some cases where this is already executed, such as Sheikh Zayed, the unity of sustainability in new urban communities and private compounds, etc.

### *3.1.1.3 Utilities*

The Egyptian Electricity Holding Company (EEHC) is an Egyptian joint-stock company established in 2000 by Law 164 which owns about 90% of generation, 100% of transmission and over 99 % of distribution. Private sector participation is manifested in three long term (20 years) BOOT contracts with the Egyptian Electricity Transmission Company. Sixteen private electricity producers are licensed, and 24 private electricity distributors are licensed.

In February 2008, the Egyptian Supreme Council of Energy set a target to have 20% of the electrical energy mix from renewable sources including 6% hydropower, 12% wind and 2% solar energy by the year 2020. Regarding solar energy, a number of technology promoting projects have also been decided within the framework of the New and Renewable Energy Authority's five-year plan 2012-2017.

The power sector has also undertaken several initiatives and measures towards energy efficiency and conservation in various sectors of consumption as follows:

- Use of high-efficiency lighting systems in various sectors
- Awareness programs on energy efficiency and conservation importance
- Increasing the efficiency of household electric appliances through standards and labelling programs

The electricity sector in Egypt faces numerous challenges. Egypt, which has been heavily subsidised in the past to provide affordable energy services to low-income households, has failed to increase generation and transmission capacity to meet the growing demand for electricity. Facing shortages in domestic gas production, an old power system infrastructure and social unrest, electricity blackouts became frequent in 2011, impeding the government to reform the sector. Energy subsidies accounted for more than 70% of all subsidies, 22% of the national budget and 7% of GDP.

With growing fiscal pressure, in 2014 the government embarked on a reform plan to gradually eliminate energy subsidies and it issued the new Electricity Law N.87 in 2015 to boost the liberalization process of its power sector and to attract international investors. Both measures did lead to a reduction of energy subsidies in the following years, coupled with low international oil prices. In fact, energy subsidies have been reduced by half compared to 2014. However, the sudden devaluation of the Egyptian pound in 2017 brought back energy subsidies to their all-time high in 2013. Taking an average from 2010 to 2017, the Egyptian government spent EGP 25 billion per year to subsidize its electricity sector. If energy subsidies are calculated based on the full economic costs from supply to distribution, this results in a total of up to EGP 58 billion per year spent on electricity subsidies, equivalent to about 3 % of average GDP from 2010 to 2017.

### *3.1.2 Private stakeholders*

#### *3.1.2.1 Project developers*

In Egypt, for single and multi-unit family houses, the decision of which cooling/heating systems to install in the buildings is taken by the owner of the unit and not the developer, unless the units are sold as fully-finished and fitted with all the systems which is not often the case. The split of percentage of single-family houses and multi-family houses implemented by the interviewed developers adds up to 37% and 41% respectively which is very comparable. This gives an indication necessary for the proper interpretation of the following results. The interviews show that only quarter of the interviewees (25%) take the decision regarding heating/cooling systems in the buildings they construct (selling units as fully finished) while the rest see it as a decision taken by the owner. Some of the interviewees, 67% do not directly take the decision but only contribute to it by giving recommendations about the cooling and heating options to the owners. Only 33% of them recommend this as early as the design stage while some do it at the construction stage or the selling and marketing stage.

#### *3.1.2.2 Banks and Funds*

The current practices in the field of energy efficiency by the banking sector in Egypt could be described as insignificant. Some banks have credit lines that support green economy in general, but there are no specific loans or grants for applying EE measures.

The largest commercial banks in Egypt include CIB Bank, Housing and development bank, HSBC Bank, EFG Hermes Investment Bank, Ahli United Bank and Bank Misr.

#### *3.1.2.3 Suppliers*

In Egypt, reversible air conditioners (heating and cooling) - multi-split (96.1%) were found to be the most imported heating and cooling technologies, followed by air conditioners (cooling only) - multi-split (94.2%) and electric resistance heaters (52.4%).

The price sensitivity of customers in Egypt to EE equipment (76.9%) is most often cited by companies as an obstacle to importing EE heating and cooling systems, followed by a lack of demand from customers for more EE equipment (46.2%). This is in line with the ranking of barriers in the country.

In Egypt, the instantaneous water heater was cited most frequently by both owners/users (85.5%) and landlords (67%). It was followed by air conditioning (heating and cooling) and air conditioning (cooling only). It is noteworthy that air conditioning systems (heating and cooling) are more strongly represented among owners/users (53.3%) than among landlords (38.5%). It appears that owners/users in Egypt have installed more types of heating and cooling equipment than landlords.

Looking at the least used heating and cooling technologies, chillers (heating and cooling) (0.3%) and solar water heaters (0.3%) appear to be the least used for owners/users in Egypt. As far as landlords in Egypt are concerned, chillers (heating and cooling) (2%) and electric resistance heaters (2%) were mentioned the least. In addition, all respondents indicated the purchase cost and installation for each type of heating and cooling equipment. It was found that in Egypt air conditioning (cooling only) costs the most, while instantaneous water heaters cost the least.

## 3.2 Stakeholder group specific drivers and barriers

### *3.2.1 Methodology*

The Housing & Building National Research Center (HBRC) and the Integrated Development Group (IDG) conducted, in the winter of 2017, 47 interviews with stakeholders in the Egyptian building sector. The aim of the interviews and interaction with stakeholders at roundtables was to:

- Assess barriers for the uptake of efficient and/or renewable energy-based cooling and heating technologies in residential buildings;

- Evaluate the role of the different stakeholder groups in the decision-making process;

- Collect recommendations on how the financial and regulatory framework should be changed to make it easier for home-owners and developers to choose efficient heating and cooling appliances rather than conventional technology systems.

The market research company GfK conducted the interviews with technology suppliers, building owners and consumers. The chosen method of surveying was Face-to-Face interviewing. A dedicated field force of experienced interviewers used tablets to conduct the interviews and immediately enter the data into the survey system during the interview. In order to facilitate the B2B survey process, it was agreed to conduct interviews based on both appointments and walk-ins.

### *3.2.2 Drivers and barriers by stakeholder group*

In the following figure, all concrete drivers and barriers for energy efficiency in Egypt, that were identified during the stakeholder interviews, are summarized. The drivers and barriers were divided into the stakeholder groups: project developers, banks, ministries, municipalities and utilities.

*„What are concrete drivers and barriers for energy efficiency in cooling & heating in Egypt?"*

| Stakeholder Group | Drivers | Barriers |
|---|---|---|
| Project Developers | Increasing **value** of developers' construction<br>**Minimizing cost** in long term<br>Increasing **client's level of comfort** | Too high **upfront investment**<br>Lack of existence **pilot projects**<br>Lack of **financial support** |
| Financial Fund/ Banks | Availability of **international funds** to boost the energy efficiency financing sector | Lack of **perceived relevance** for heating and cooling systems<br>**No regulations** from the goverments<br>**Inflation and devaluation** risk |
| Ministries | High electricity **prices**<br>Improvement of health and building environment | Too high **upfront investments**<br>**Lack of standards** for energy efficiency |
| Municipalities | **Giza as role model**: incentive systems to promote energy effiency | **No incentives** to attract people to install efficient systems |
| Utilities | Trend towards PV on rooftops<br>**Obligations** to promote energy efficiency | Too **high price of PV** on rooftops |

**Figure 6. Drivers and barriers for energy efficiency as learned in stakeholder interviews**

#### *3.2.2.1 Public Authorities*

**Drivers for EE**

Regarding the drivers for increasing energy efficiency in buildings in Egypt, all interviewees in this group of Ministries and Authorities of Housing and Energy answered that high electricity prices are the main driver for increasing EE in buildings to reduce energy costs. Other drivers to increase EE were also: the dependency on energy imports (33%), the need to meet the government's energy efficiency targets/Egypt National Determined Contribution (44%), energy security (67%), international trends toward energy efficiency (78%), the need to reduce $CO_2$ emissions (89%), to attract funding from (international) donors (78%), to improve health and building environment and comfort (89%).

Ministry of Planning: The Ministry of Planning controls capital expenditures of national budgets and investments. It is a member of the decision-making cycle of resource allocation and advises policy makers in each sector they propose. It is the key role player and reports to the cabinet. A variety of banks are already offering real estate financing programs, e.g. the Housing & Development Bank. Financing programs for energy efficiency measures could be implemented in those existing real estate housing programs.

**Barriers for EE**

Ministries and Authorities of Housing and Energy: Regarding the barriers for the uptake of efficient and/or renewable energy-based cooling and heating technologies in residential buildings, interviewees from this group saw following aspects: 78% thought upfront investments are too high for potential investors, 67% mentioned a lack of financial support/subsidies for potential investors, 44% lamented a lack of attractive bank (soft) loans, 78% mentioned a lack of awareness related to technical energy efficiency options among potential investors, 44% found a lack of awareness related to technical energy efficiency options among architects/engineers/project developers, 33% deplored a lack of technical know-how among architects/engineers, 10% said that low energy prices do not provide enough financial attractiveness, 44% said the regulatory framework is not strong enough, 78% find a lack of standards for energy efficiency (minimum technical requirements but also labels to inform stakeholders etc.) and 67% complained about a lack of enforcement.

Ministry of Planning: From the point of view of a representative of the Ministry of Planning, the key barrier is the lack of integration between policies and the weak legislative framework. Another major obstacle is the lack of high-level political support that can allow the central bank to set a funding scheme to be adopted by banks. This leads to the marginal role of the national and commercial banks in supporting the energy efficiency field. To overcome this, coordination between the legislative authorities, the Ministry of Finance, the Ministry of Planning and the Central Bank is necessary.

Since the priorities of the Ministry are still primarily focused on satisfying basic needs in the buildings sector, increasing energy efficiency is currently not (yet) assigned greater importance. To meet the significant rise in energy costs in recent years, improving energy efficiency in the Egyptian building sector is of fundamental importance. In order to reduce negative impacts on the acceptance of energy-efficient solutions, more incentives for users of EE-solutions should therefore be created and awareness of energy-saving technologies should be raised.

#### *3.2.2.2 Municipalities*

The new urban municipality "6th of October" is located in Giza Governorate, a satellite town and part of the urban area of Cairo, Egypt, 32 km outside the city and currently the only municipality that has an incentive system to promote energy efficiency in the creation of new cities across Egypt. Other municipalities in Egypt lack incentive system and laws to promote energy efficiency.

#### *3.2.2.3 Project Developers*

One third of the project developers (33%) stated that efficient cooling and heating systems play a role in their residential housing projects. Some found them more suitable for the single-family houses, while others saw that it could play a role in their future projects, even if it is not yet the case in the present. Some drivers of their interest were identified by the interviews as follows:

- Energy efficiency measures are good for their image and as a marketing aspect to attract certain segments. It is also a means of differentiating their projects from their competitors, as every developer is searching for a unique selling point of their units.
- It increases the value of the buildings constructed by the developers.
- It reflects some companies' real environmental concerns.
- As a response to the clients' wish of increasing their level of comfort while minimizing the total cost of the asset over lifetime use, the investment cost and having the fastest payback period, companies are searching for more efficient systems with lower costs.
- Measures are a response to the clients' wish of maintaining a certain image or status through their adoption.

Consultants (architects and engineers): A higher percentage of consultants (60%) compared to developers consider the efficient systems to play a role in their residential projects specifically. They share the same drivers with the developers but with changing weights. The clients' wishes come first, followed by the other drivers.

- Energy efficiency measures are a response to the clients' wish of minimizing the investment costs and the total cost of the asset over the lifetime use as well as having the fastest possible payback period.
- They are a response to the clients' wish of reducing the energy consumption in the future especially with the increasing electricity prices that will follow the subsidy removal plan by the government.
- The systems are profitable for the clients when looking at the savings potential and long-term cost reduction. The systems also increase the value of the clients' building when they resell it on the market.
- It is good for their image as consultancies.
- Measures are implemented due to the increasing trend of LEED accreditation in buildings in Egypt.

**Barriers for EE**

Project developers: Two third of the project developers (67%) thought that the efficient cooling and heating systems do not play a role in their residential projects. The main barrier to their consideration of such measures is the fact that the owners take the decision regarding these systems in the majority of the residential projects and accordingly it is not the developers' job to take care of it. The rest of the barriers could be divided as follows:

Economic barriers: The way developers evaluate these measures is by considering the high investment costs of the more efficient systems that they will pay which will increase the price of the units and may affect their attractiveness and marketability to the targeted segment, without getting any benefits or savings in return since all the savings go to the owner over the lifetime of the system and not to the developer whose role ends by selling the unit. Accordingly, it will only be of economic attractiveness, if the targeted segment is a high-income group and so the additional costs of the systems when added to the unit price will not be a put-off. In case of commercial spaces and other spaces rented by the developers to clients, part of the running costs' savings actually goes to the developer, motivating his investment in such systems. The fear of losing the competitiveness and marketability of the units when installing the more efficient systems was shared by 42% of this group. 58% did not think that these systems are more profitable/economically feasible to install than the conventional ones they usually install. Also, some believed that there is a lack of willingness of the clients and investors to have the more efficient cooling and heating systems.

Technical barriers: These include the lack of existence of pilot projects for showcasing the advantages and disadvantages of these technologies, the lack of accurate information about the liability of these technologies and the capacities of available suppliers, the shortage in information and benchmarks of the residential units' performance to guide the calculations done during the selection of the systems, as well as the lack of proper knowledge of these efficient systems in-house and among the consultancies. The lack of technical capacity and shortage of qualified technical personnel in the company were among the fewer mentioned barriers (only by 17%) as many believed that the technical aspects are not the main problem but rather the financial aspects.

Organizational barriers: One of the barriers for the developers is that they cannot force the clients to use a specific type of cooling and heating systems as it could demotivate them from buying the apartments. Also, if they use a central system that is applied to the whole building and only one apartment becomes inhabited, the developer has to operate the whole system and so will have to pay the expenses of a running system that is partially utilized (a costly inefficient act). Based on their practice, some developers mentioned that around 30 - 40 % of the apartment owners in multi-family houses do not actually live in them, they leave them for another phase in their life or as an investment, so they will not be interested in buying the apartment with the system already installed.

Others found that such measures will require a third-party involvement in the contract which is the supplier of the system, a thing they are willing to avoid and also to avoid the hassle accompanying the installation and maintenance of the system.

Consultants (architects and engineers): Since the efficient systems were not taken into consideration in the residential buildings by only 40% of the consultants, the range of barriers was a lot more limited mainly focusing on the economic barriers.

Economic barriers: On top was that there is a lack of proper financing instruments; hence the technologies are not being financially supported. Accordingly, with the current prices, they do not see the more efficient cooling and heating systems as more profitable or economically feasible in comparison to the conventional. Therefore, they believe that even their clients will not be wishing to invest in such systems. This might be the reason why some of the interviewees mentioned that they still do not have the in-house technical knowledge of the efficient systems, as there is still no real demand for them in their market.

#### *3.2.2.4 Banks and Funds*

**Drivers for EE**

Currently there is no stable source of energy supply in Egypt and the demand is expected to increase strongly, causing a huge gap between the supply and demand, which makes the need for alternative sources and EE measures necessary. The interest and commitment of the current government to EE measures has grown after recognizing that energy efficiency is a forward-looking and comparatively cheap way to save energy costs. Awareness of the added value of energy-efficient measures is not yet reflected in the commitment of the financial sector. Accordingly, the interviews inquired what needs to be done by the banking sector to accelerate the adoption of these measures. 75% of the interviewees agreed that the availability of international funds is a key driver to boost the energy efficiency financing sector in Egypt. Several banks (almost 45% of interviewees) mentioned that they were already on track of green financing but have not completely developed systems or targeted EE measures yet.

A successful business and financing model is represented by the GEFF which could be replicated to similar development institutions in Egypt. The offering of technical assistance by experts is as important as offering the loan itself to ensure the implementation of the project in the most optimal way, however only 36% of the interviewed banks provide it. The mentioned credit lines are still not available for the residential sector as there is no current demand for that specifically but there are optimistic plans that new financing schemes currently under study will be dedicated to the home owners and developers as well, not only enterprises and suppliers of technologies as the common case.

The creation of a financing scheme and dedicated credit line in banks is a top down approach as mentioned by 64% of interviewees who belonged mostly to national and local commercial banks. There has to be a political will to direct all efforts towards financing energy efficiency measures, and the central bank then has to support such an initiative. The banks alone can't initiate a mechanism like that without prior approval from the central bank. This is one obstacle, another major obstacle as agreed upon by all interviewees is the inflation and devaluation risk and the high interest rates to clients.

The lack of awareness among the banks is another barrier, where, unfortunately, all interviewees had no clear understanding of the technologies and their most bankable solutions but only an overview of the concepts of heating and cooling and EE measures in general. In addition, the majority of bankers had no background on initiatives as GEFF and their ability to initiate similar financing mechanisms. There is also lack of awareness by the developers and end users of the environmental cost when neglecting these measures as well as the potential savings they could achieve. The focus is directed more towards RE devices rather than EE measures, although decreasing the demand is cheaper and considered more of a fast track solution in comparison to increasing the supply.

There are few ESCOs in Egypt, but they are not widely known amongst bankers and even end users. Although studies show that there are approx. 10 ESCOs currently working in the Egyptian market, the interviewees' opinion is that ESCOs are not active in Egypt to an extent that makes it visible and attractive to target clients.

**Barriers for EE**

As a result of the field interviews, most banks stated that heating and cooling systems are not a relevant aspect for them in lending money. Almost 60 % of banks don't find it relevant because of three main reasons: first, a lack of understanding of the technologies which led to having no interest to fit it in their portfolios, second, the fact that no regulations or incentives from the government exists to help stimulate demand from customers, and third that energy savings and EE measures are not conventional assets that they are able to lend money to. Almost 25% stated that a main obstacle is quantifying the benefits and risks of EE measures especially heating and cooling technologies, which is also a very legitimate barrier related to the lack of knowledge and awareness of the systems.

#### *3.2.2.5 Utilities*

100% of interviewees from utilities see a trend toward more residential rooftop PV, 84% perceive energy efficiency in buildings and deployment of residential rooftop PV as an opportunity because consumers benefit from reducing their consumption. Among the drivers was that the companies of 50% of interviewees have obligations to promote energy efficiency since the strategy adopted by the Egyptian power sector includes, among others, energy efficiency improvement on supply as well as demand side to ensure a sustainable and reliable supply of electricity, reduce greenhouse gas emission and mitigate the effects of climate change. Accordingly, there are driving forces towards effecting a change.

34% of interviewees from utilities perceive energy efficiency in buildings and deployment of residential rooftop PV as a challenge because of the high price of PV component and the mismatch between extended working hours at the night and most PV energy being produced at day light.

#### *3.2.2.6 Technology suppliers*

The interviewed technology suppliers from Egypt gave feedback on drivers and obstacles to the import of energy efficient (EE) heating and cooling technologies.

In Egypt, the price sensitivity of customers to EE devices (76,9%) was most frequently cited as an obstacle to importing EE heating and cooling systems, followed by a lack of demand from customs for more EE appliances (46,2%). This is in line with the ranking of barriers in the country.

In addition, the respondents argued that high purchasing costs, governmental restrictions, and economic and political situation in the country are the underlying causes for the lack of demand.

87,8% of the respondents said that increasing demand from the customers for EE heating and cooling technologies drive them to import more EE heating and cooling technologies in the future. This however appears to be a contradictory driver because it was early considered as a barrier. In the process of surveys, a certain margin of contradictory responses is always present and factored in because of the nature of the survey itself (i.e. the subjectivity of the feedback), which always plays a role even when limiting the number of open-end questions.

The second driver mentioned the most (66,7%) was called first-mover advantage. In other words, companies intend to be the first in the market to import new products and gain competitive advantage. The trends of drivers are in line with the ranking result in which market demand is the primary motive and first-mover advantage the secondary one.

#### *3.2.2.7 Consumers*

When consumers were asked in the survey what drives them to install EE heating/cooling appliances, friends' recommendations were indicated the most among owners/occupiers (54,5%) and landlords (75%) in Egypt.

By asking what prevents consumers from installing energy efficient (EE) heating and cooling appliances, the lack of consciousness in the choice of this type of appliances was mentioned the most among owners/occupiers (58,2%) and landlords (61,3%), followed by personal financial reasons (owners/occupiers: 35,2%; landlords: 47,6%).

## 3.3 Main results and learnings from Pilot Projects

| Project | Boundary Conditions | | Proposed Technical Measures |
|---|---|---|---|
|  Porto Pyramids, Cairo | 270 | Expected inhabitants | Energy efficient windows |
| | 10,800 m² | Conditioned floor area | Improve roof and wall insulation |
| | 290 K*d | Heating Degree Days | Shading |
| | 1,800 K*d | Cooling Degree Days | Air tightness |
| | 1,914 kWh/m² | Solar Irradiation p.a. (horizontal) | Increased efficiency of cooling |
| | | | Photovoltaics and solar thermal collectors |
| | | | Adjust set temperature for cooling/heating |
|  Upscale Nabta Town | 156 | Expected inhabitants | Improve roof and wall insulation |
| | 2,328 m² | Conditioned floor area | Shading |
| | 387 K*d | Heating Degree Days | Air tightness |
| | 1,367 K*d | Cooling Degree Days | Increased efficiency of cooling |
| | 2,053 kWh/m² | Solar Irradiation p.a. (horizontal) | Photovoltaics and solar thermal collectors |
| | | | Adjust set temperature for cooling/heating |

**Figure 7. Overview of pilot projects conducted in Egypt**

### *3.3.1 Porto Pyramids, Cairo*

#### *3.3.1.1 General Information*

The Porto Group operates as one of the largest privately held corporations in Egypt as an established leader in the hospitality industry and one of the largest resort developers. Porto Group launched the new development project Porto Pyramids in 2016. This project is already in the construction phase,
located ~18 km from Cairo, North Egypt. The master plan includes 16 unit types, a 5-star hotel, a spa and gym, swimming pools, and a club house. The project site is located close to major businesses and shopping centres, enabling short commutes. The total plot area of the site is about 100.000 m². The selected pilot

**Figure 8: Porto Pyramids Neighbourhood**

within this area is a residential multifamily house with 10.800 m² conditioned floor area that includes 54 apartments to serve 270 expected residents.

The external temperatures range from more than zero to 41°C with average annual temperature of around 24°C. December is the coldest month; July is the hottest. The minimum temperature does not fall to less than 0°C. There is greater energy demand for cooling than heating, with more than 1,800 cooling degree days compared with the 290 heating degree days. In Cairo, there is big potential for renewable energy within solar irradiation. Horizontal irradiation of 1,914 kWh/(m²*a) and more than 1000 kWh/(m²*a) for east, south, and west orientation create opportunities for energy generation through solar radiation and solar cooling.

The mean energy prices are EGP 0.13 per kWh (EUR 0.01-0.06 per kWh) for electricity and EGP 3.65-6.6 per kWh (EUR 0.168-0.3 per kWh) for oil. For Egypt, two energy price scenarios have been calculated, as removal of energy price subsidies is planned in coming years.

**Table 1: Main information of Pilot Project**

| Criteria | Input |
|---|---|
| Number of expected inhabitants | 270 |
| Utilisation | Residential |
| Year of construction | 2016-2019 |
| Number of floors | Five plus parking |
| Number of apartments | 54 |
| Conditioned floor area | 10,800 m² |
| Clear room height | 2.7 m² |
| Conditioned volume | 29,160 m³ |
| Roof area | 2,400 m² |
| Wall area | 3,906 m² |
| Floor area | 2,400 m² |
| Window fraction per orientation (N/E/S/W) in m² | Not available/691/113/691 |

#### *3.3.1.2 Baseline and Current situation*

The baseline situation reflects the usual business construction practice in a respective country. It deviates from the available building codes, as major players in the construction practice don´t always respect building codes. In Egypt, the key components of a baseline energy concept are a split unit supplying heating and cooling with a Coefficient of Performance (COP) of 2.5; hot water is supplied by an electric instantaneous appliance. No thermal insulation or renewable energy sources are considered for a baseline project, as the following table illustrates.

This approach results in the following energy breakdown: cooling energy represents the largest portion of the demand with a total of 70.5%, the heating demand reaches 13.9% of the total demand, and the smallest shares are domestic hot water and lighting with 4.9% and 4.8%, respectively. This demand results in energy consumption of 94.1 kWh/(m²*a) and an environmental impact of 62 kg CO2e/(m²*a). Depending on the energy tariff, the square meter will range between EGP 20.4/(m²*a) and EGP 61.3/(m²*a) or between EUR 0.9/(m²*a) and EUR 2.8/(m²*a).

To improve on the baseline approach, the following current planning was shared with the Porto Pyramids BUILD_ME project: use of thermal insulation in the roof and external walls to reduce thermal losses and use of overhangs, balconies, and fixed louvres to reduce solar gains (see bold marked measures in the following table's Current Situation column).

**Table 2: Energy parameters, Baseline and Current Situation**

| Measure | Baseline Situation | Current Situation |
|---|---|---|
| **Roof insulation** | 3 W/m²K | **0.63 W/m²K** |
| **Wall insulation** | 1.8 W/m²K | **0.44 W/m²K** |
| Floor insulation | 3 W/m²K | 3 W/m²K |
| Windows | 5.7 W/m²K, G = 0.85 | 5.7 W/m²K, G = 0.85 |
| Window fraction | Ø 40% | Ø 40% |
| **Shading** | No | **Overhangs, balconies, fixed louvres** |
| Heating system | Reversible split unit - COP 2.5 | Reversible split unit - COP 2.5 |
| Cooling system | Reversible split unit - COP 2.5 | Reversible split unit - COP 2.5 |
| Hot water | Electric instantaneous | Electric instantaneous |
| Ventilation system | Natural | Natural |
| Lighting system | LED | LED |
| Renewable energy | No | No |
| Temperature setpoint: heating | 23°C | 23°C |
| Temperature setpoint: cooling | 23°C | 23°C |

Note: Bolded entries indicate those that differ from the baseline values.

#### *3.3.1.3 Variants*

**Technical description – Variant 1 | Low Investment**

The first variant (low investment) calculates the energy performance of measures with a payback of less than 2 years. Variant 1A considers current energy prices, and variant 1B refers to energy prices without subsidies (high energy prices).

**Variant 1A – Low Energy Price**

This package differs from the current situation in the following measures: a reduced window fraction of 20% and an appropriate indoor temperature setting that is both energy efficient and respects thermal comfort bands. These low or no cost measures are a response to the available low energy price, which doesn´t justify a high investment in energy efficient measures due to the lack of resulting financial feasibility.

**Variant 1B –- High Energy Price**

This package, which assumes not subsidised, real energy prices, consists of the following main measure: improved roof insulation compared with Variant 1A.

### Table 3: Energy parameters Variant 1A and 1B

| Measure | Variant 1A | Variant 1B |
|---|---|---|
| **Roof insulation** | 0.63 W/m²K | **0.45 W/m²K** |
| Wall insulation | 0.44 W/m²K | 0.44 W/m²K |
| Floor insulation | 3 W/m²K | 3 W/m²K |
| Windows | 5.7 W/m²K, G = 0.85 | 5.7 W/m²K, G = 0.85 |
| **Window fraction** | **Ø 20%** | **Ø 20%** |
| Shading | Overhangs, balconies, fixed louvres | Overhangs, balconies, fixed louvres |
| Heating system | Reversible split unit - COP 2.5 | Reversible split unit – COP 2.5 |
| Cooling system | Reversible split unit – COP 2.5 | Reversible split unit – COP 2.5 |
| Hot water | Electric instantaneous | Electric instantaneous |
| Ventilation system | Natural | Natural |
| Lighting system | LED | LED |
| Renewable energy | No | No |
| **Temperature setpoint: heating** | **20°C** | **20°C** |
| **Temperature setpoint: cooling** | **26°C** | **26°C** |

Note: Bolded entries indicate those that differ from the current situation values.

**Technical Description – Variant 2A – High End | Low Energy Price**

The second variants seek to reduce energy consumption as much as possible, reaching a nearly zero energy level through the integration of renewable energies. At the same time, the financial feasibility of measures must respect a simple formula: payback period smaller than lifetime. This highly energy efficient package consists of the following measures: adjusting set temperatures (20°C for heating, 26°C for cooling), an increased COP of 3.5 for cooling and heating, windows with a U-value of 3.1 W/m²K and a G-value of 0.3, no shading but solar glazing, a 20% window fraction, and further improved U-values for the roof (0.36 W/m²K) and walls (0.4 W/m²K).

**Technical Description – Variant 2B – High End | High Energy Price**

The second variant that assumes nonsubsidised, real energy prices includes further improved windows with triple glazing (U-value of 0.8 W/m²K) and a G-value of 0.3, an increased COP of 5 for cooling and heating, additional solar thermal tubes for the hot water supply, and the use of PV as a renewable energy source.

Table 4: Energy parameters Variant 2A and 2B

| Measure | Variant 2A | Variant 2B |
|---|---|---|
| **Roof insulation** | **0.36 W/m²K** | **0.36 W/m²K** |
| **Wall insulation** | **0.4 W/m²K** | **0.4 W/m²K** |
| Floor insulation | 3 W/m²K | 3 W/m²K |
| **Windows** | **3.1 W/m²K, G = 0.3** | **0.8 W/m²K, G = 0.3** |
| **Window fraction** | **Ø 20%** | **Ø 20%** |
| **Shading** | **No (solar glazing)** | **No (solar glazing)** |
| **Heating system** | **Reversible split unit – COP 3.5** | **Reversible split unit – COP 5** |
| **Cooling system** | **Reversible split unit – COP 3.5** | **Reversible split unit – COP 5** |
| Hot water | Electric instantaneous | **Solar thermal (tubes)** |
| Ventilation system | Natural | Natural |
| Lighting system | LED | LED |
| Renewable energy | No | **PV** |
| **Temperature setpoint: heating** | **20°C** | **20°C** |
| **Temperature setpoint: cooling** | **26°C** | **26°C** |

Note: Bolded entries indicate those that differ from the current situation values.

#### *3.3.1.4 Results – Comparative Overview A – Low Energy Prices*

The energy consumption decreases by each new introduced variant (from baseline to Variant 2A) by 30%-40% for each step of improvement, resulting in energy consumption savings compared with the baseline of 30% for the current situation, 53% for Variant 1A, and 74% for Variant 2A. The CO2 emissions and energy cost savings follow the same pattern.

The investment costs for the current situation are approximately 20% higher than for the baseline. However, Variant 1A is cheaper than the current situation and offers around 33% energy consumption savings for the allocated measures. This cost savings is the result of a Variant 1A measure that cost less than what was initially planned—specifically, the window fraction reduction results in investment cost savings, as windows are more expensive than external walls.

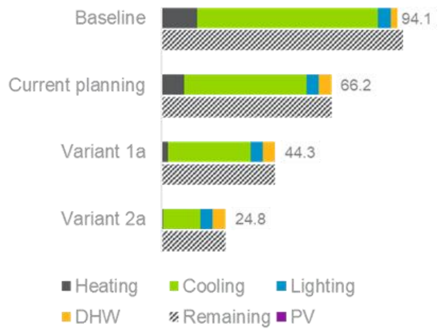



Figure 9: Specific final energy demand [kWh/(m²*a)]

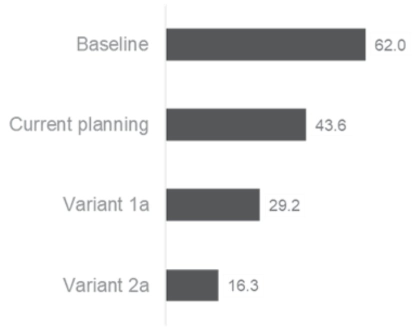



Figure 10: Specific emissions [kg CO2e/(m²*a)]

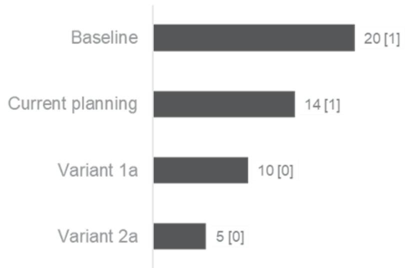



Figure 11: Specific energy costs EGP/(m²*a) [EUR/(m²*a)]

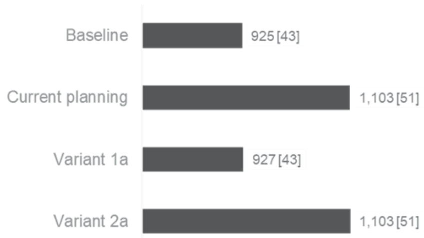



Figure 12: Specific investment costs EGP/(m²*a [EUR/(m²*a)]]

#### *3.3.1.5 Results – Comparative Overview B – High Energy Prices*

A scenario that integrates more energy efficiency and renewable energy measures, and considers the nonsubsidised, real energy prices, results in higher energy consumption savings. Compared with the baseline, Variant 1B saved approximately 60% and Variant 2B saved 100%. In terms of investment costs, compared with the baseline, Variant B costs were 20% higher and Variant 2B were roughly 100% higher (the investment costs were twice as high). For Variant 2B, the energy consumption savings are the result of solar energy technologies (solar thermal and PV) that enable the project to reach nearly net-zero energy building (NZEB).

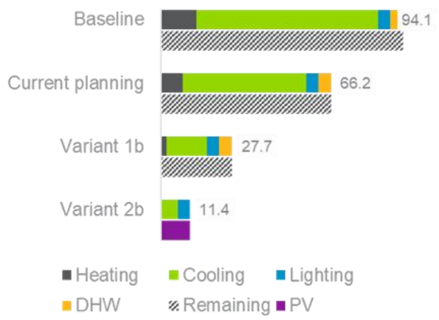



Figure 13: Specific final energy demand [kWh/(m²*a)]

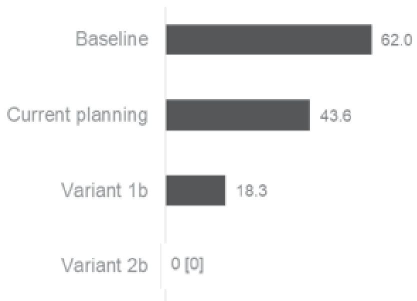



Figure 14: Specific emissions [kg CO2e/(m²*a)]


**Figure 15: Specific energy costs EGP/(m²*a) [EUR/(m²*a)]**

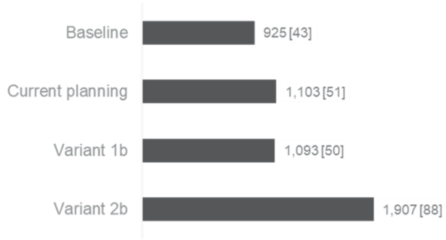



**Figure 16: Specific investment costs EGP/(m²*a [EUR/(m²*a)]]**

#### *3.3.1.6 Recommendation*

Two measures should be taken to reduce the energy demand for buildings under construction. First, educate future homeowners about the need to adjust target temperature for cooling and heating (e.g., through flyers and handouts). Second, improve the thermal insulation of the roof, targeting a U-value of 0.45 W/m²K or better.

In addition, future planning should aim to develop zero-energy houses by using highly insulated envelopes, the most energy efficient window fraction (20%), heating and cooling systems with reversible split units with a COP of at least 5, solar thermal hot water systems (vacuum tubes), an optimal proportion of PV, and a target temperature for cooling and heating of 26°C/20°C. To use the solar energy on the roof, an unshaded space towards the south should be reserved for the installation of PV/solar collectors (e.g., when installing water storage tanks, satellite dishes). In addition, local suppliers should demonstrate the cost advantages of PV and solar thermal energy to future homeowners.

#### *3.3.1.7 Implementation (still to come)*

The Porto Pyramid pilot project construction is still not complete (as of September 2019), but the project developer promised to reassess the potential deployment of building envelope measures and their financial feasibility in a more advanced stage. Furthermore, the developer expressed interest in solar PV and behaviour-related measures. The Porto Group claimed to be very satisfied with the technical assistance received in the project and stated interest in further working with Guidehouse in a potential second IKI (International Climate Initiative) project phase. In that case, the dissemination of technical knowledge on energy efficiency measures to managers and engineers should be considered according to the developer.

### *3.3.2 Upscale Nabta Town, Egypt*

#### *3.3.2.1 General Information*

Upscale Egypt is a young, enthusiastic development company with a unique approach towards urban development. Launched in 2015, Upscale is introducing the first entrepreneurial college town concept in Middle East and North Africa, called Nabta Town. By combining a range of functions through defined but integrated neighbourhoods, Nabta Town serves as an inclusive and highly attractive community. The development offers live, work, education, culture, and play to its residents and visitors, with the premise of human progress at its core.


**Figure 17: Illustration of Upscale Egypt**

Although the project is in its concept phase, the majority of plans have been settled. The master plan is divided into six zones that offer various features, including a university, as well as residential and commercial neighbourhoods. The total plot area is 540.000 m² and is located within a 13 km distance from Borg El Arab Airport and 45 km from Alexandria. The number of permanent residents is expected to be 5,460, excluding college residents.

The climate in the region of the Alexandria is primarily hot and humid. External temperatures range from more than zero to 35°C, with yearly average temperatures around 21°C. There is greater energy demand for cooling than heating, as the high number of more than 1,300 cooling degree days indicate compared with the 380 heating degree days. The horizontal irradiation of more than 2,000 kWh/(m²*a) and more than 1000 kWh/(m²*a) for east, south, and west orientation creates opportunities for energy generation through solar radiation.

The mean energy prices are around EGP 0.13 per kWh (EUR 0.01-0.06 per kWh) for electricity and EGP 3.65-6.6 per kWh (EUR 0.168-0.3 per kWh) for oil. For Egypt, two energy price scenarios have been calculated, as removal of energy price subsidies is planned in the coming years.

**Table 5: Main information of Pilot Project**

| Criteria | Input |
|---|---|
| Number of expected inhabitants | 156 |
| Utilisation | Residential/commercial |
| Year of construction | Starting in 2020 |
| Number of floors | Five |
| Number of apartments | 24 |
| Conditioned floor area | 2,328 m² |
| Clear room height | 2.72 m² |
| Conditioned volume | 7,584 m³ |
| Roof area | 977 m² |
| Wall area | 1,645 m² |
| Floor area | 987 m² |
| Window fraction per orientation (N/E/S/W) in m² | 230/7/200/7 |

#### *3.3.2.2 Baseline Situation*

The baseline situation reflects the current approach to construction in a respective country. It deviates from technical regulations as construction practices do not always respect technical regulations. The key components of the energy concept of this baseline scenario are the heating and cooling systems with a COP of 2.5 and hot water supplied by an electric instantaneous appliance. It has been assumed that no thermal insulation and no renewable energy sources are considered for the project.

In this baseline scenario, cooling energy represents the largest portion of energy demand with a total share of 74%. Domestic hot water reaches 17% of total demand and heating and lighting have the smallest shares with 6% and 3%, respectively. The current situation has an energy demand of 135.4 kWh/(m²*a) and an environmental impact of 60.1 kg CO2e/(m²*a). For a unit of 90 m², the energy cost will reach about EUR 10.50-30.75 per month or EGP 220.50 -661.50. This represents the standard building package.

The current situation differs from the baseline scenario, as thermal insulation of the roof, wall, floor and windows are improved to reduce thermal losses. Additionally, district heating and cooling is used.

**Table 6: Energy parameters, Baseline and Current Situation**

| Measure | Baseline Situation | Current Situation |
|---|---|---|
| **Roof insulation** | 3 W/m²K | **0.457 W/m²K** |
| **Wall insulation** | 1.8 W/m²K | **1.14 W/m²K** |
| **Floor insulation** | 3 W/m²K | **1.85 W/m²K** |
| **Windows** | 5.7 W/m²K, G = 0.85 | **1.69 W/m²K, G = 0.66** |
| Window fraction | Ø 21% | Ø 21% |
| Shading | No | No |
| **Heating system** | Reversible split unit - COP 2.5 | **District heating** |
| **Cooling system** | Reversible split unit - COP 2.5 | **District cooling** |
| Hot water | Electric instantaneous | Natural gas |
| Ventilation system | Natural | Natural |
| Lighting system | LED | LED |
| Renewable energy | No | No |
| Temperature setpoint: heating | 21°C | 21°C |
| Temperature setpoint: cooling | 23°C | 23°C |

Note: Bolded entries indicate those that differ from the baseline values.

#### *3.3.2.3 Variants*

**Technical Description – Variant 1 | Low Investment**

The first variant, low investment, calculates the energy performance of measures with a fast payback of less than 2 years, while Variant 1A considers the current energy prices and Variant 1B refers to energy prices without subsidies (high energy prices).

**Technical Description – Variant 1A/Variant 1B – Low Investment**

For this package, Variant 1A and Variant 1B include the same measures. Compared with the current situation, the window fraction is reduced to a maximum 20% per orientation. The low energy price does not justify expensive measures. Therefore, the only additional difference to the current situation is an adjustment to the temperature setpoint for heating and cooling.

**Table 7: Energy parameters Variant 1A and 1B**

| Measure | Variant 1A/Variant 1B |
|---|---|
| Roof insulation | 0.457 W/m²K |
| Wall insulation | 1.14 W/m²K |
| Floor insulation | 1.85 W/m²K |
| Windows | 1.69 W/m²K, G = 0.66 |
| **Window fraction** | **Max 20% per orientation** |
| Shading | No |
| Heating system | District heating |
| Cooling system | District cooling |
| Hot water | Natural gas |
| Ventilation system | Natural |
| Lighting system | LED |
| Renewable energy | No |
| **Temperature setpoint: heating** | **20°C** |
| **Temperature setpoint: cooling** | **26°C** |

Note: Bolded entries indicate those that differ from the current situation values.

**Technical Description – Variant 2A – High End | Low Energy Price**

The second variants seek to reduce the energy consumption as much as possible, reaching a nearly NZEB level with the integration of renewable energies. At the same time, the financial feasibility of measures must respect a simple formula: Payback period smaller than lifetime. Compared with the low investment variant, this highly energy efficient package consists of the following measures: improving the U-values of roof and wall insulation and changing the heating and cooling system to an efficient split AC with a COP of 5.

**Technical Description – Variant 2B – High End | High Energy Price**

The second variant, which assumes nonsubsidised, real energy prices, allows further improvements due to larger financial latitude. The improvement is realised by exchanging the electric hot water system with 45% solar thermal support and a PV system.

Table 8: Energy parameters Variant 2A and 2B

| Measure | Variant 2A | Variant 2B |
|---|---|---|
| **Roof insulation** | **0.36 W/m²K** | **0.36 W/m²K** |
| **Wall insulation** | **0.4 W/m²K** | **0.4 W/m²K** |
| Floor insulation | 1.85 W/m²K | 1.85 W/m²K |
| **Windows** | 1.69 W/m²K, **G = 0.3** | 1.69 W/m²K, **G = 0.3** |
| **Window fraction** | **Ø 20%** | **Ø 20%** |
| Shading | No | No |
| **Heating system** | **Split AC – COP 5.0** | **Split AC – COP5.0** |
| **Cooling system** | **Split AC – COP 5.0** | **Split AC – COP 5.0** |
| Hot water | Natural gas | Electric/**solar thermal 45%** |
| Ventilation system | Natural | Natural |
| Lighting system | LED | LED |
| **Renewable energy** | No | **PV** |
| **Temperature setpoint: heating** | **20°C** | **20°C** |
| **Temperature setpoint: cooling** | **26°C** | **26°C** |

Note: Bolded entries indicate those that differ from the current situation values.

#### *3.3.2.4 Results*

For Nabta Town, the energy consumption of the current situation is similar to the baseline scenario. The differences add up to about 4%. For the next step of improvement, the energy consumption decreases by more than 50%. Variant 2A offers another approximate 40% energy savings, and Variant 2B reduces energy demand to zero when taking into account nonsubsidised, real energy prices and the utilization of PV. However, the specific emissions show a different trend. Whereas almost 50% CO2 emissions can be saved during the current planning compared with the baseline, further emission reduction with Variant 1A/Variant 1B are rather small due to the “good” standard of the current planning. The improvements offered by Variant 2A save another 34%, and with Variant 2B, the specific emissions decrease to zero. The specific energy costs follow a similar trend.

In terms of investment costs, the additional measures of each variant translate into rising specific investment costs. Whereas Variant 1A and Variant 1B investment costs stay the same as the current situation, the change of specific investment costs between Variant 1A/Variant 1B and Variant 2A and between Variant 2A and Variant 2B amounts to about 35%. The specific investment costs of the current planning are 39% lower than the investment costs of the baseline.

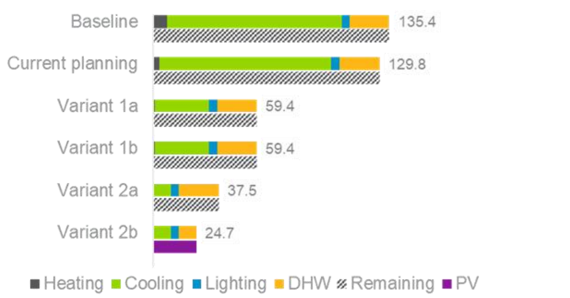



**Figure 18: Specific final energy demand [kWh/(m²*a)]**


**Figure 19: Specific emissions [kg CO2e/(m²*a)]**

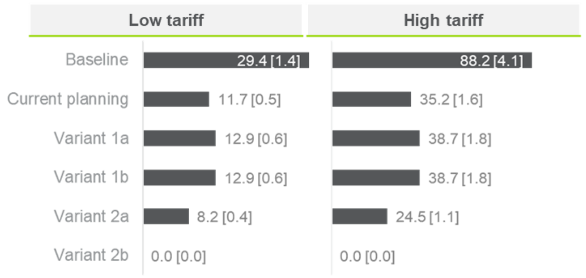



**Figure 20: Specific energy costs LBP/(m²*a) [EUR/(m²*a)]**

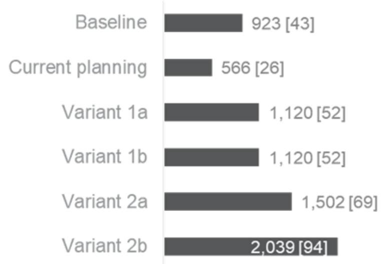



**Figure 21: Specific investment costs LBP/(m²*a [EUR/(m²*a)]]**

### *3.3.2.5 Recommendation*

As the planning and construction of the Nabta Town buildings will take place in the near future (from 2020) and further energy price increases are expected until then (reduction of subsidies), it is recommended to aim for a nearly NZEB. Furthermore, the dependencies of the NZEB with the planned district cooling supply system should be checked, as the lower demand influences the feasibility of the central supply system (district cooling). In any case, the key points of the energy concept should include a campaign to increase awareness to adjust the appropriate setting temperature for cooling and heating. Building energy demand should be reduced by passive measures such as thermal insulation and shading elements. To utilise solar energy on the roof, unshaded space towards the south should be reserved for the installation of solar thermal systems. Moreover, high efficiency cooling systems are crucial to realise lower energy consumption.

### *3.3.2.6 Implementation (Still to Come)*

Upscale Egypt received the recommendations and stated interest in all proposed measures, considering implementation especially for measures relating to the building envelope and solar PV. The developer claimed to be very satisfied with the technical assistance received in the project. As of December 2018, the project was still in the design and permit stage. Upscale Egypt expressed interest in continuing the work with Guidehouse should the IKI project be extended.

# 4. PROPOSED POLICY MEASURES AND EXPECTED IMPACT

## 4.1 Proposed Policy Measures to Address Challenges

Based on the key findings of the first project phase, a set of policy modules per stakeholder group was developed to address the identified barriers to the development of the construction sector in Egypt towards zero emissions. In a three-part approach, the rationale, implementation and impacts were analyzed.

### *4.1.1 Public Authorities*

#### *4.1.1.1 EGY_PA_01: Cross cutting national awareness campaigns regarding the phase out of energy subsidies and the improved benefits of energy efficiency in the building sector*

- **Rationale:** With energy subsidies currently covering 80-90% of utility cost of production in Egypt, electricity prices are the lowest in the MENA region, dis-incentivizing investments in energy efficiency. These subsidies have created a lack of awareness on the macro-economic benefits of every kWh that is not consumed in Egypt and how a reduction in energy subsidies could translate in improved public services. The Egyptian government has taken the decision to enforce cost-reflective tariffs of electricity in 2022 and will phase out gradually energy subsidies in the country. This decision will trigger gradually more attractive business cases for energy efficient measures in the building sector, which will impact all stakeholders.

- **Implementation:** The Ministry of Housing and industrial organizations should collaborate to lead a nation-wide awareness campaign to raise the awareness on energy efficiency on all job levels from students to professors, engineers and industrials, bankers and investors, municipalities and ministers. Bankers will need to attend training to understand how to develop business opportunities of energy efficiency lending (Recommendation IV in banking). Municipalities will need to be trained to inspect the conformity of building design with the energy efficiency code (Recommendation VI). To raise the awareness of citizens and to facilitate the procurement of energy efficient services, a national website grouping all information on the potential of energy efficiency measures in residential households and the contacts of certified ESCOs able to implement these measures should be built. To fortify the linkages between industry and research in energy efficiency, it would be necessary to raise the awareness of industries on the existence of the Technology Transfer Marketing Office existing at HBRC and other universities. In universities, directors should raise the interest of professors in encouraging their students to choose final year projects in the field of energy efficiency and organize national competitions between universities to award best in class projects.

- **Impact:** Increasing the awareness about energy efficiency of each stakeholder group on a national level and their role in accelerating energy efficiency measures will collectively and effectively drive the market demand for energy efficient products in Egypt.

#### *4.1.1.2 EGY_PA_02: Implement integrated pilot projects in residential buildings and raise awareness on the results of the project*

- **Rationale:** In Egypt, integrated pilot projects in the construction sector involving cooperation and collaboration between all local actors are lacking. There is a need to understand the role of each stakeholder in the process of implementing energy efficiency measures and the interdependencies between the role and responsibilities of each actor.

- **Implementation:** The Ministry of Housing initiates national pilot projects for new residential compounds in different cities of Egypt, inviting the relevant public and private stakeholders concerned in round tables to agree on a roadmap going forward with the execution of the pilot project. The project developer concerned is responsible to raise awareness on the results of the project, highlighting the deliverables of each stakeholder in contributing to the success of the project.

- **Impact:** Increasing awareness and alignment across stakeholders in Egypt on the value of energy efficiency in residential buildings in the country.

#### *4.1.1.3 EGY_PA_03: Mandatory certification of engineers to the Egyptian Energy Efficiency Code*

- **Rationale:** The engineering offices do not implement the energy efficiency code in practice because they do not have the necessary knowledge about it. National experts with many years of experience in the development of the Building Code stated that the majority of engineers (>75%) are not certified energy efficiency experts. Engineers in Egypt oversize heating and cooling systems, giving priority to safety and comfort over efficiency, and do not design control systems to optimize operation and reduce energy costs. Heating and cooling load modelling is rarely performed. Some project developers admitted that they have no knowledge of conducting load analyses for the heating and cooling needs of the building and therefore only use the usual approaches to select or recommend technologies for their clients.

- **Implementation:** The Egyptian Engineers Syndicate has the responsibility and authority to design, organize and complete the examination as well as the right to nullify the licenses of engineers who fail the exam. The Syndicate will be responsible to offer trainings to engineers. The training is provided on a voluntary basis at the expense of the engineers. The test shall be designed in different sections targeting different sectors in the design, construction and inspection of new residential buildings, that is civil and mechanical engineers who work in a contracting company will have a test tailored to the design phase of energy efficiency measures whereas engineers who works in a municipality will have a test tailored to the inspection of energy efficiency measures in the construction phase.

- **Impact:** Re-examining the knowledge of engineers will fortify the missing link between the Egyptian Energy Efficiency Building code and the application of the code and provide a boost for energy efficiency to surpass the business as usual approach in the building sector.

#### *4.1.1.4 EGY_PA_04: Update permitting rules for new buildings with respect to the Egyptian energy efficiency code*

- **Rationale:** Currently Chapter 10 of the Egyptian energy efficiency building code requires engineers to compute a detailed building performance analysis over a whole year with climatic data. However, there is currently no specific ceiling on the final energy consumption per square meter. Establishing such a limit would ensure that a benchmark is fixed to qualify a non-energy efficient building from an efficient one.

- **Implementation:** Ministry of Housing

- **Impact:** Including an energy efficiency certificate for new buildings in the permitting process will force engineers to adapt their designs to a specific final output, that is simple for municipalities to understand and check the conformity. In addition, it will improve the accuracy of energy consumption forecasts in Egypt for the future.

#### *4.1.1.5 EGY_PA_05: Strengthen enforcement systems in the construction and maintenance phase, applying severe penalties to the engineering design company for non-compliance to the energy efficiency building code and to the facility manager of the residential building for not reporting annual energy consumption*

- **Rationale:** Most projects submit an initial plan to the authorities and are then amended several times without prior notice. In addition, municipal inspectors lack the engineering expertise to verify the conformity of innovative energy-efficient solutions.

- **Implementation:** The Egyptian Engineers Syndicate (EEA), the Ministry of Housing, the Directorate of Housing and Utilities in different governorates and the districts presidency offices in the cities' districts collaborate to form an independent body of certified inspectors. This third-party will have the responsibility to ensure a reliable inspection and a correct enforcement of the building code for new buildings. The Ministry of Housing must grant the authority to this party to set penalties for non-compliance. The EEA is responsible to certify the inspectors. International consultants can support the EEA for the certification process if requested. This third-party will also be responsible to monitor the annual energy consumption of new buildings.

- **Impact:** This recommendation is likely to have a high impact as it ensures the implementation of the energy efficiency measures stated at the design level and for which the developers benefited from incentives. It will also provide a new database to authorities in order to monitor the annual energy consumptions of new buildings and verify annual energy savings.

### 4.1.2 Project Developers

#### 4.1.2.1 EGY_PD_01: Develop a new local Building Rating System and obligate its use for all new buildings starting by large-scale developments until reaching the smallest scale.

- **Rationale:** Currently, there is no adopted rating system suitable for the Egyptian context or contributing to the increased adoption of energy efficiency measures. The Green Building Pyramids rating system is an Egyptian rating system developed in 2011 but was not strongly implemented and eventually faded away. LEED is the main rating system adopted in Egypt nowadays, mainly in office and commercial buildings but is faced by severe criticism for its lack of suitability to the context and for being adopted mainly for maintaining status with doubtful impacts on the actual buildings' sustainability. Accordingly, there is no rating system that targets to raise the awareness of the consumers (Units' owners) and clarify the extent of economic benefits by adopting energy efficiency and RE measures. Similar to the labelling of household appliances, which translates into monthly savings in energy consumption, there is an urgent need for an evaluation system that awards buildings with a label (in the form of certification) and indicates an economic value for the benefit of the building's measures.

- **Implementation:** The development of context-specific building rating systems is the key for a true transformation of the Egyptian building sector towards 0-emission ambitions. It should be a rating system that targets the consumers, putting a monetary value on the benefits of the energy efficiency residential units they will buy at an extra cost. The main aim of the rating system is to translate each certification level into the amount of savings gained from the reduction of energy consumption as a result of the measures implemented in the building. The development of this rating system needs to start as an initiative by the Ministry of Housing in collaboration with the Ministry of Electricity and Renewable energy. A new entity affiliated to the Ministry of Housing can be initiated to be responsible for the development of this rating system and the evaluation and certification of buildings at a later stage. The support of local and international consultants and advisors can be requested on demand from the parties. The enforcement of the rating system could start as optional for new buildings over the course of 3 years to act as a transitional period preparing the market for its complete obligation afterwards with given financial incentives. The level of certification could be linked to the financial incentive received by the project developers; linking with recommendation II.

- **Impact:** The development and obligation of this new rating system will open the way for a market of greener buildings, where it provides a justification for project developers and investors to go greener without the fear of losing the attractiveness and marketability of their units since their clients now have a transparent system of measuring and evaluating the benefits of these energy efficiency units. Such step pushes the construction market towards the adoption of a wide range of energy efficiency measures ranging from the simplest to the most complex and extravagant, where different development scales can aim at different measures with escalating levels of certifications. It also paves the way for the development of financial supporting mechanisms by having a transparent methodology for evaluating and ranking the sustainability and energy efficiency level of the development projects benefiting from the incentives

#### *4.1.2.2 EGY_PD_02: Create a regulatory framework to offer incentives for project developers applying the building code and implementing energy efficiency and renewable energies solutions e.g. reduction in cost of land, increase of built-up area, extra floor allowance, cross-subsidies, tax reductions, credit lines for soft loans at low interest rates*

- **Rationale:** There is a huge gap when it comes to financial incentives and facilitations that support the adoption of energy efficiency measures in Cairo. No financial mechanisms were developed for the support of energy efficiency, they only focused on supporting renewable energy measures, accordingly the implementation rates are very low in comparison to the benefits obtained. The only attempt is a regulation, currently under study, to give incentives to developers who implement energy efficiency measures in their projects in the form of a longer allowance period for their payment by instalments. However, a lot more is still needed.

- **Implementation:** Financial facilitations are needed from the banks' side to support the adoption decision of both the project developers and individual owners. It could follow a top-down approach from the central bank and Ministry of Finance as well as the Ministry of Planning where they approve a credit line with lower interest rates and set regulations to all banks to support individuals to buy or build energy efficient buildings or adopt energy efficiency measures to existing buildings. Another option is to follow a more bottom-up approach where the banks themselves initiate credit lines or small soft loans and subsidized financing strategies fitting the residential sector and the individuals. The incentives should differentiate the different levels of ambitions and scales of adoption ranging from the projects with the highest ambitions till the minor interventions adopted by individual owners (reflected by the certification of the rating system; recommendation II).

- **Impact:** Through the interviews with the project developers, the need for incentives to motivate and support their adoption of energy efficiency measures became very clear. Accordingly, this policy is expected to have a huge impact on supporting the adoption of the measures that still have high costs until a competitive market is achieved and the prices start to decrease. Usually energy efficiency measures with highest NPV are the measures that save the highest energy over lifetime, however with longer paybacks they do not get chosen. If there are now incentives to drive them forward, engineers will choose the technologies with the greatest impact, and eventually awareness of the potential of the measures will spread and acceptance of the measures will increase.

#### *4.1.2.3 EGY_PD_03: Public Sector should lead National initiative with Pilot Projects adopting energy efficiency policies, approaches and solutions as to increase national ambition on energy efficiency targets*

- **Rationale:** Currently, there is only a limited number of pilot projects adopting energy efficiency measures and they are all focusing on one of two measures either using efficient lighting units (LEDs) or implementing solar water heaters mainly in the public buildings sector. The New Urban Communities Authority (NUCA) has been leading these pilot projects in the authorities' building as well as a number of the agencies' buildings. Also, a number of buildings of the Ministry of Electricity and Renewable Energy and its affiliated authorities have adopted these measures as a showcase but only for these limited measures.

- **Implementation:** The Ministry of Housing and the New Urban Communities Authority (NUCA) need to take the initiative of implementing pilot projects adopting a wider range of energy efficiency measures and approaches not only in public buildings but also in the residential projects they build in order to lead the market by example. There has to be focus on the measures and approaches that were not tested enough and have not gained popularity in the market. Also, the Ministry of Electricity and Renewable Energy needs to implement pilots for the different ideas and initiatives that support energy efficiency and renewable energies adoption. The publicity and dissemination of the outcomes of these projects is crucial for showcasing the potentiality of the measures and for learning from the experiences. Such projects could be supported by local and international organizations in the field whether through technical assistance, co-financing or complete funding.

- **Impact:** Seeing the outcomes of such projects will have the greatest impact on reducing the uncertainty and the status-quo bias of most project developers and house owners who have an unclear idea about the feasibility of the systems and have no trust in the market, suppliers or technicians. The pilots will break this cycle and put the measures on display for awareness and learning by doing.

#### *4.1.2.4 EGY_PD_04: Simplify energy efficiency code in check list format and strengthen its enforcement system by linking it to permits acquisition*

- **Rationale:** The first energy efficiency code was issued in Egypt twelve years ago starting by the residential buildings in 2006, followed by the energy efficiency code for commercial buildings in 2009 and finally the one for governmental buildings in 2011. However, the adoption of these codes remained voluntary and not obligated by any law or regulation. Therefore, the awareness of the existence of Energy Efficiency codes for buildings among the architects and engineers working in the field is extremely limited which was also proved from the conducted interviews. And for those who know about the code and its contents, they find difficulty in applying it in practice due to its complexity and lack of clear quantifiable aspects that need to be fulfilled in their newly designed buildings.

- **Implementation:** HBRC (Housing and Building Research Center), responsible for the development of the codes, can create a committee from the in-house experts and from external local experts in the field for reviewing the existing energy efficiency code and finding ways for its simplification and improvement. Needless to say, the importance of involving practitioners and professionals in the field in the committee to create an easy to use energy efficiency code that it is in compliance with market conditions and existing technologies. The developed measures need to be taken into consideration in the development of all new codes like the code for district cooling that is currently under development by HBRC as well. The obligation of this code has to be done by a Ministerial decree from the Ministry of Housing and issued in the official gazette. There has to be link between the code implementation in the new projects and permits acquisition which could be coordinated between HBRC and the municipalities (mainly the districts presidency offices all over the cities‘ districts) responsible for issuing the building permits. The code could define and obligate the minimum requirements while any extra measures taken by the owner or project developer can be rewarded via different incentives. A complementary policy to this one is capacity building and certification of engineers (recommendation IV) without which the code obligation becomes obsolete.

- **Impact:** Having a code guiding the adoption of energy efficiency measures is crucial not only for increasing the adoption rates of the energy efficiency measures but also for ensuring high-quality practices. It also facilitates the role of the engineers and architects by having a guide to refer to; a need stressed in the interviews with them.

#### *4.1.2.5 EGY_PD_05: Mandate the certification of engineers on rating systems and related energy efficiency codes as well as certification of energy assessors for conducting energy audits and building capacity in the field of the financial calculations of the actual feasibility of the systems*

- **Rationale:** The number of engineering consultancies specialized in the field of green buildings and the design and sizing of energy efficiency and renewable energies measures is very limited all over Egypt. In the new electricity law, it is obligatory for the buildings consuming 500kW or more to undergo energy audits and energy management as well. Because of this obligation, RECREE, Arab League and Ministry of Electricity and Energy offer capacity building for the engineers to be certified to offer these services. Despite that, national experts with long due experience in developing the building code stated that the majority of engineers (>75%) are not certified energy efficiency experts, accordingly the need for a certification for engineers whether on the developed rating system or codes or energy audits is urgent.

- **Implementation:** In addition to the efforts that has been done by RECREE, Arab League, Ministry of Electricity and Energy and Ministry of Housing, the Egyptian Engineers Syndicate and HBRC need to be also involved in the development and implementation of this certification procedure. They could also make use of the expertise of other accredited governmental training centers and international or local educational and professional training institutions specialized in building the capacity of professionals in the field of engineering and construction. The syndicate or HBRC could take the lead in offering the trainings to the engineers and in conducting the certification qualifying tests. The training will be voluntary at the engineers' own cost. The test shall be designed in different sections targeting different sectors in the design, construction and inspection of new residential buildings, that is civil and mechanical engineers who work in a contracting company will have a test tailored to the design phase of energy efficiency measures whereas engineers who works in a municipality will have a test tailored to the inspection of energy efficiency measures in the construction phase.

- **Impact:** The true enforcement of rating systems or relevant codes cannot be put in action without having the certified calibres equipped with the needed knowledge to conduct such evaluations. Accordingly, putting this policy in action is a prerequisite of the two policies related to the obligation of rating systems and energy efficiency code.

#### *4.1.2.6 EGY_PD_06: Raise the awareness of end users on the potential savings and benefits of the energy efficiency measures*

- **Rationale:** Raising awareness of the end users was seen by 76% of the interviewees as the key measure for increasing their rates of adoption. This is because one of the main barriers for the project developers is the fear of losing the attractiveness and competitiveness of their residential units to the targeted segments if their prices increased due to the implementation of the energy efficient measures which is only a put off if clients are unaware of the benefits, they could render over the life time of the systems.

- **Implementation:** The government needs to launch a serious energy efficiency awareness raising campaign similar to what was done in the efficient lighting (LED) campaign that was started by UNDP in 2011. It should be disseminated through all types of media channels (TV, radio and social media). The Ministry of Electricity and Renewable Energy, Ministry of Housing and Ministry of Supply and Internal Trade need to cooperate in launching this campaign; this can also be supported by the Consumer Protection Authority (CPA) that played a crucial role in previous campaigns related to the same field, in addition to any experienced local or international agency. Building on policy I, the pilot public projects can play a crucial role in raising awareness and setting the example, eventually changing perceptions as well as shifting the market towards becoming more energy-efficient.

- **Impact:** Devising financial incentives and regulatory framework that leads to building more energy-efficient buildings alone is not enough, where awareness of a more efficient lifestyle is needed. By raising this, individual owners will be convinced to invest in energy efficient measure and will be fully aware of the benefits and gains they get out of that.

### *4.1.3 Suppliers*

#### *4.1.3.1 EGY_S_01: Support local industry to increase efficiency level of ACs by turning the Energy Efficiency standards for appliance from guideline to mandatory*

- **Rationale:** One of the main barriers local industries are facing in assembling energy efficient technologies is the fear to lose competitive edge with other suppliers, who chose low cost equipment to sell at minimum upfront cost to their customers. The currently existing standard for Air Conditioners is a guideline and not a mandate. By banning the production, assembling and import of technologies that do not respect the Energy Performance Standards set in the standard, authorities can ensure to suppliers the same level playing field. In addition, such enforcement would facilitate the sales of efficient equipment's in retail stores as equipment will be labelled with respect to the standard.

- **Implementation:** The Egyptian parliament need to pass a legislation to turn the Air Conditioners Energy Efficiency Standard No. 3795 into a mandatory requirement and authorize the existing testing laboratory to pass high fines on non-compliant products. The laboratory will run random compliance tests on the produced, assembled and imported heating and cooling products in Egypt.

- **Impact:** Ensuring European labelling or equivalent on products entering the market will impose a certain minimum level of safety and performance. Giving Incentives to products with an energy efficient European label (or equivalent) will ensure that importers target the right quality of technologies.

#### *4.1.3.2 EGY_S_02: Have accredited labs to validate the performance of the products assembled by the Egyptian industries*

- **Rationale:** Accredited performance testing laboratories have been established at the Egyptian Renewable Energy Testing & Certification Center testing and certification and specifications

#### *4.1.3.3 EGY_S_03: Build capacity at the supplier's floor staff level on the economic and environmental benefits of energy efficient technologies imported in the country*

- **Rationale:** Our interviews with 400 consumers in Egypt proved that the biggest driver for them to purchase an energy efficient heating or cooling technology at a retail store is the ability of the vendor to present convincing arguments to defend the case. Vendors should guide customers in their purchase, explaining that the benefits of energy efficiency pay off over the lifecycle of the equipment and how the present value of the technology should be their decision factor for a profitable investment. They should inform them about the coming possibility of financing mechanism to cover the additional upfront cost.

- **Implementation:** A number of authorities and organizations need to come together to organize different trainings and workshops on the potentials of energy efficiency technologies and the extent of their benefits for stronger marketing of them to customers. These include the Egyptian Environmental Affairs Agency (EEAA), the Egyptian organization for Standardization, Egyptian Organization for Standards and Quality (EOS). Support could be given by RCREEE, being experienced in organizing similar workshops that aim at raising the level of awareness of the suppliers' staff. Also, local and international consultancies could provide such type of training or support the involved entities technically.

- **Impact:** Increasing shares of energy efficiency product sold in supplier portfolio

### *4.1.4 Banks*

#### *4.1.4.1 EGY_B_01: Disseminate best practices of international financing organizations active in Egypt in supporting local SME investing in energy efficiency and renewable energies projects*

- **Rationale:** Since their engagement in Egypt, the EBRD and IFC gained valuable experience in understanding the particularities and dynamics of the banking sector in Egypt and gathered lessons that can guide banks how to reduce risk factors of lending to local manufacturers. For example, AlexBank, QNB and NBK bank each managed funds of USD 30 million, USD 40 million, USD 30 million respectively co-financed by the EBRD. The fund is structured in four categories of loan limits depending on the type and size of project. The repayment plan is up to 5 years, depending on the loan type and project conditions. The interest rate is 3%

plus Central Bank of Egypt's lending rate for EGP with a minimum of 12%. An investment grant of 10% or 15% of loan amount is available depending on loan type. The participating banks not only offer financing to clients but also technical support as well as investment grant incentives after successful completion, which is one of the most interesting features of this program.

- **Implementation:** The three international organisations (EBRD, EIB, IFC/World Bank) must work together to organise a national workshop for commercial banks in order to disseminate the results of their funding programme and the experience gained in dealing with local commercial banks. It is necessary to invite the Ministry of Planning, Ministry of Finance and the central bank to participate in the workshop.

- **Impact:** Disseminating best practices of international financing organizations is a necessary pre-cursor to create a regulatory framework in Egypt in order to allow commercial banks to offer low interest loans to end-users investing in Energy Efficiency projects.

#### *4.1.4.2 EGY_B_02: Disseminate best practice of MENA countries, as well as European countries, that have established an Energy Efficiency Fund*

**Rationale:** Since 2005, Tunisia provides financing for energy efficiency measures via the National Fund for Energy Savings. Its revenues come from taxes on the first registration of cars as well as on import and manufacturing of air conditioners, from the savings achieved by energy efficiency activities, and from private donations. The fund subsidizes measures such as energy audits, power and heat co-generation and substitution of natural gas. It also assists in meeting the minimum energy efficiency specifications for residential and administrative buildings that were set in 2008-09.

In Jordan, the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) signed agreements with local banks to finance renewable energy projects. JREEEF funds individuals and SMEs, mostly in the industrial and tourism sectors. In Lebanon, the National Energy Efficiency and Renewable Energy Action (NEEREA) a national financing mechanism was initiated by the Central Bank of Lebanon (BDL) that finances solar, wind, biomass and hydro projects in addition to energy efficiency measures and green building projects. In Egypt, no explicit energy efficiency funding mechanism exists which slows down the uptake of energy efficient projects and access to low-interest funding.

- **Implementation:** Best practices of energy efficiency funds should be disseminated at the workshop of recommendation I. All three international organizations (EBRD, EIB, IFC/World Bank) have experience in setting up and managing energy efficiency funds, e.g. World Bank in Tunisia. Additionally, representatives of JREEEF and NEEREA should present experiences. Representatives of the Central Bank of Egypt, Ministry of Planning, Ministry of Energy and Ministry of Finance as well as representatives of local commercial banks should attend the workshop.

- **Impact:** Disseminating best practices of Energy Efficiency Fund establishment is a necessary pre-cursor for convincing high-level political representative to allocate funds to it.

#### *4.1.4.3 EGY_B_03: Establish an energy efficiency fund to support credit guarantees and pilot project in the field of energy efficiency in residential sector*

- **Rationale:** There is no fund in Egypt to support commercial banks in lending low interest loans to residents interested in purchasing an energy efficient house or to encourage project developers, engineering firms, universities and municipalities to collaborate in building a net zero energy building using state of the art technologies and disseminating the results. The key barrier for establishing such fund is the lack of high-level political support and innovation in approaches and policies. Currently, energy efficiency is not prioritized by public authorities as needed. Yet the government misses the opportunity to realize that the cost to benefits ratio of savings 1 kWh of energy outweighs the cost to benefits ratio of subsidizing 1 kWh of generated energy.

- **Implementation:** The Central Bank and the Ministry of Planning and the Ministry of Finance need to cooperate in order to define the arrangements for the establishment of the fund and the allocation of a body to manage the fund, e.g. "Energy Efficiency Agency". This body will have the power to grant commercial banks a certain percentage of the repayment of the loans they grant for energy efficiency credits. By offering this money-back strategy, the risk of the energy efficiency loan will be reduced, and this will increase the willingness of banks to lend money for energy-efficient projects. In addition, the entity will have an annual budget to fund pilot projects in Egypt to drive innovation and collaboration between all stakeholders.

- **Impact:** Establishing a fund will be a key enabler for implementing the following recommendation and recommendation II of Public Authorities.

#### *4.1.4.4 EGY_B_04: Create a regulatory framework for commercial banks to offer credit lines with low interest rates to citizens investing in new buildings that have been certified by the Green Pyramid Building Rating system and manufacturers investing in capacities to increase efficiency of their heating and cooling equipment*

- **Rationale:** In a context of low energy prices and high interest rates, the energy efficiency market cannot be triggered without financial incentives. Yet commercial banks in Egypt have never been active in financing energy efficiency projects or services targeting the residential sectors neither did they support local manufacturers in upgrading their assembly lines and technologies to target higher efficiencies (except the recent banks who joined EBRD and IFC programs). With the gradual phase out of energy subsidies by 2022, the business case of energy efficiency measures will change and a regulatory framework that enables commercial banks to offer low interest loans for energy efficiency applications needs to be initiated by the government.

- **Implementation:** The central bank of Egypt in collaboration with the Ministry of Finance and Ministry of Planning issue a circular to commercial banks. Citizens can benefit from low interest loans to purchase energy efficient apartments under the condition that the building has been rated by a developed local rating system. The interest of the loan should be adapted to the ratings. The higher the rating (Silver -> Golden -> Green), the lower the interest on the loan. The circular address also local manufacturers who are aiming to increase the efficiency of their locally manufactured heating and cooling equipment. The efficiency levels can be compared to international benchmarks e.g. Energy Star (US) or the Energy Efficiency Labelling Scheme (EU). The interest of the loan will be tailored to the efficiency level they are targeting to reach.

- **Impact:** Creating such a framework will directly increase market demand for energy efficient houses in the country, indirectly impacting project developers who will adapt their offering to customer demand and purchase efficient products from local manufacturers.

#### *4.1.4.5 EGY_B_05: Offer training and capacity building to support bank officers in understanding the context and business opportunities of Energy Efficiency lending, with a focus on efficient heating and cooling technologies*

- **Rationale:** Because of the non-conventional nature of the cash flows of an energy-efficient asset, bankers do not understand how to value energy-efficient solutions and view their applications similarly to ordinary goods rather than depreciable assets.

- **Implementation:** International consultants can train bankers in understanding the impact of bank loans on the value of energy efficiency measures and how to categorize these from least to highest impact with respect to financial indicators. Two initiatives have recently kicked off. One from the Arab African bank and Frankfurt School of Business "Mostadam -

sustainable energy for bankers" and one by EBRD and GIZ "Basic sustainable energy knowledge for bankers" which can be taken as a guide for other initiatives.

- **Impact:** Providing such training will improve the ability of bankers to turn energy efficiency lending into innovative banking products, reducing lending risks and opening new market segments, e.g. ESCOs.

## 4.2 Impact Assessment of Proposed Policy Measures

### *4.2.1 Methodology*

**General approach:**

The rough overall approach to the impact assessment is:

- Development of policy modules containing a description of the different measures, their qualitative impacts and approach how to implement.
- For each of these measures, the impact on the future system distribution in new constructions will be assumed (determining shares) for three periods and the affected share of all new constructions for the envisaged future distribution of space heating technologies, hot water generators, space cooling systems, ventilation systems and different envelope measures. Our assumptions are based on a) the results of the interview conducted with stakeholders b) data collected from pilot projects c) Navigant CBA tool to estimate which technologies will be most cost-effective given future energy prices and capital cost development of EE technologies d) guest estimates on market parameters which were not possible to quantify in the scope of our project
- Considering the different technology distributions, efficiencies and affected shares, we use our Building Energy Performance (BEP) Model to calculate the energy demand and resulting emissions of the different building configurations.
- Combining these results of the efficiency cases (measures) with results of the Business-As-Usual (BAU) case then allows the calculation of energy and emission reductions.
- For determining the number of new constructions in the three countries, we use our Global Building Stock Model that contains building stock data and projections of these stocks for all countries of the world until 2050 and beyond.

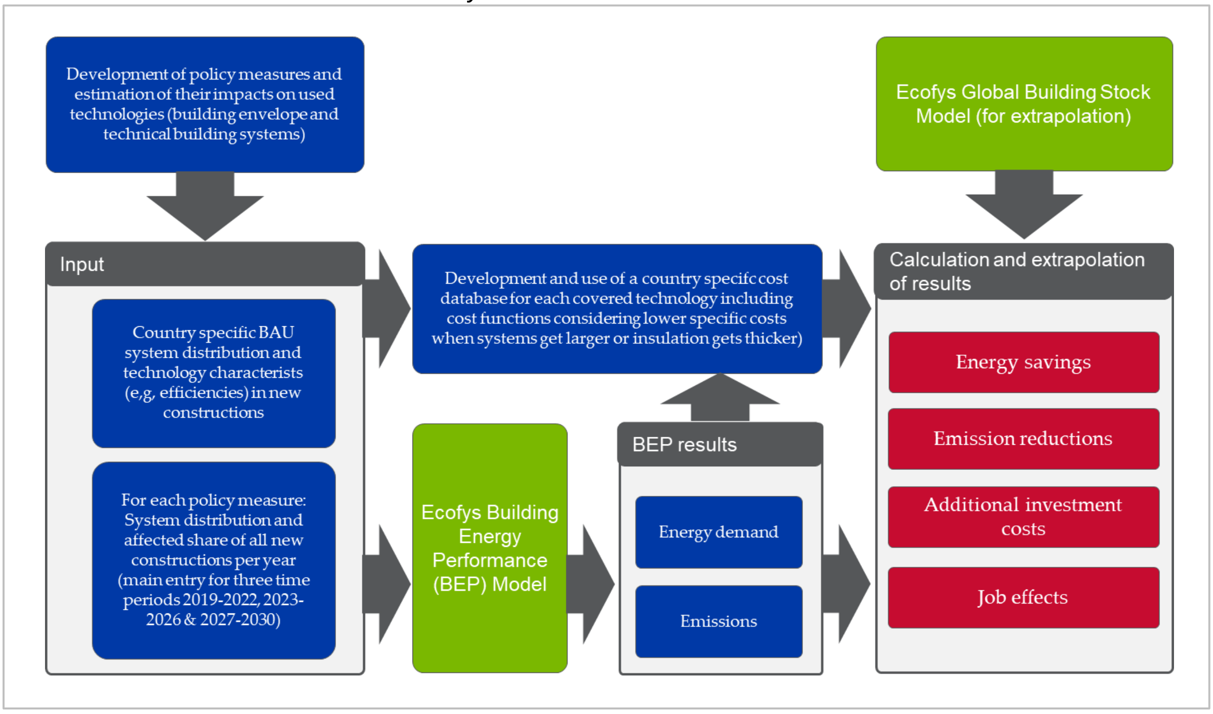



**Figure 22: Definition of BAU path**

The BAU path has been defined as a „Frozen Technology Reference Level ", meaning that the energetic quality of today's new constructions remain stable until 2030.

**Navigant Building Energy Performance (BEP) Model:**

The logic of our BEP model is illustrated in the figure below. The calculation core for calculating the useful net energy demand of a building is based on ISO 13790 (currently being updated to ISO 50016). To run the hourly calculations, the model is using a reference building and also needs other information such as climate data of the specific location of the building we extract from METEONORM.

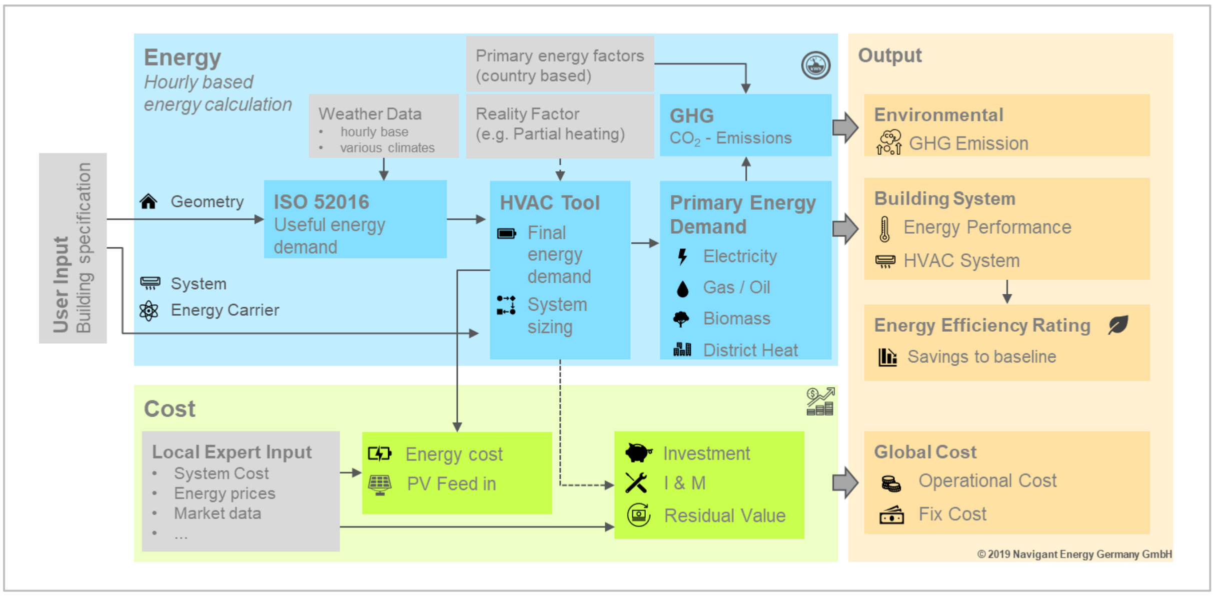



**Figure 23: Navigant Building Energy Performance (BEP) Model**

**Navigant Global Building Stock (GLOBUS) Model:**

The Navigant Global Building Stock Model uses an algorithm for calculating the size of the building stock applying correlations between economic strength (measured in GDP/capita) and available floor space per capita based on literature and own research projects. Population growth data is extracted from the "United States Census Bureau" and GDP growth assumptions from the IEA World Energy Outlook (WEO).

The methodology allows the calculation of residential and non-residential floor space separately and is based on Navigant` experiences in building stock research. The model and its underlying formulas are based on building stock statistics from about 50 countries worldwide and has continuously improved over recent years.

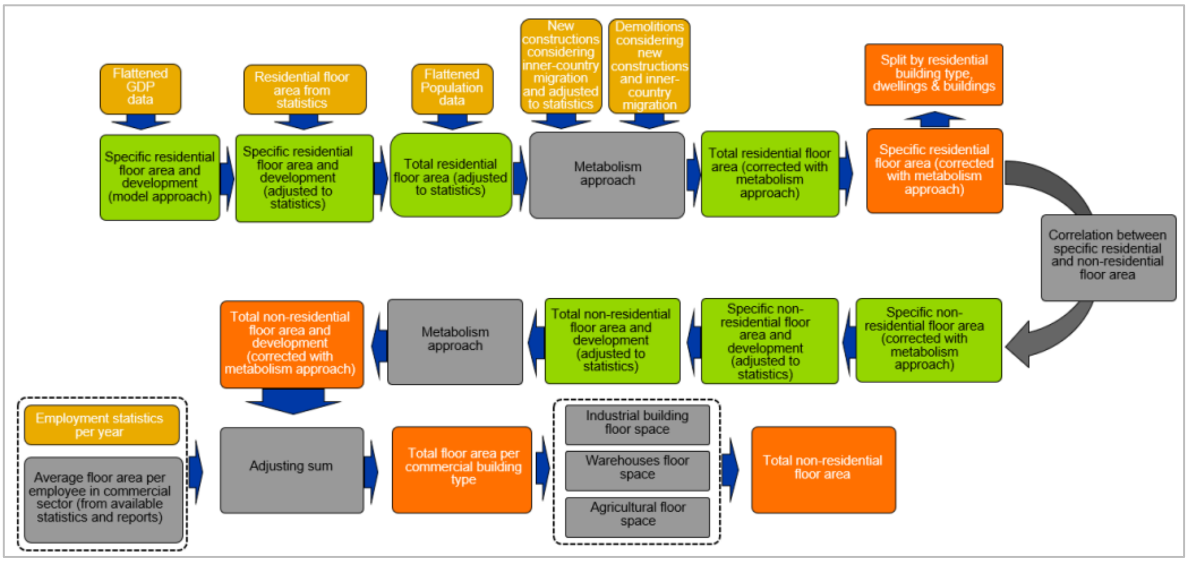



**Figure 24: Illustration of the overall approach of Navigant's Global Building Stock (GLOBUS) Model**

**Reference building specifications:**

We considered information from partners and experiences from other building sector related projects in the MENA region and therefrom designed one reference building with an average geometry that suits the requirements of the impact assessment and allows calculating representative results. It is a 6 story multi-family house with one attached wall as often constructed in the urban centers of the MENA region. The details of the geometry etc. are presented in the table below.

**Table 9: Reference building**

| Building parameter | Unit | Value |
|---|---|---|
| Inhabitants | - | 69 |
| Shading factor for static external objects | - | 0.90 |
| Thermal building class | - | Very light (80,000 J/K) |
| Building levels (floors) | - | 6 |
| Floor height (Floor to ceiling) | m | 2.90 |
| Net floor area (i.e. living area) | m² | 2,073 |
| Roof area | m² | 350 |
| Façade area opaque | m² | 928 |
| Thereof north | m² | 382 |
| Thereof east | m² | 0 |
| Thereof south | m² | 382 |
| Thereof west | m² | 164 |
| Window area transparent | m² | 242 |
| Thereof north | m² | 92 |
| Thereof east | m² | 0 |
| Thereof south | m² | 100 |
| Thereof west | m² | 50 |
| Area floor slap | m² | 350 |

**Determination of future technology distributions and affected shares:**

For each of the developed measures we assume future technology distributions and the affected shares of all new constructions. Our assumptions are based on a) the results of the interview conducted with stakeholders b) data collected from pilot projects c) CBA tool developed by Navigant to estimate which technologies will be most cost effective given future energy prices and capital cost development of EE technologies d) guest estimates on market parameters which were not possible to quantify in the scope of our project

Starting point for the future distributions is the current BAU distribution in the countries. BAU distribution in this sense means the currently present shares of different technologies that in average can be found in all new constructions of one year. Based on the type of measure, we then exchanged with our national partners on the effect of these measures on the technologies to be used in the future. As an example: In case, the measure is promotion program for Solar Water Heaters (SWH), the impact direction is clear. You could assume 100% SWH, then just still need to think about the affected share of this measure. Considering the size of the measure (e.g. program) but also the addressed stakeholder target group and implementation strategy for example the assumption could be that the program will affect 20% of all new constructions. This would mean, that the model would use a 20% share of all new constructions using the 100% SWH technology distribution and 80% BAU distribution.

In our overall calculation approach, we distinguish between three periods:

- 2019-2023
- 2024-2026
- 2027-2030

This way, we also allow a “movement” in the future development of the impacts of the measures. Related to the technology distributions and affected shares this means that the model requires input to all three periods. For some of the measures, this option can be used to consider a potential change in the future distribution. But also, the affected shares of the measures can be adjusted. An example could be that it is assumed that a measure is just starting slowly e.g. due to different market barriers or the initially small size of the program but then over time is getting more and more important, therefore the assumed affected share is growing.

**Calculation of greenhouse gas abatement costs:**

The results of the impact assessment also comprise the calculated abatement costs. For the calculation, the following approach has been used:

1. Sum of all additional investments (compared to BAU) taken between 2018 and 2030, annualized assuming a loan period of 25 years (assumed average between demand and supply side measures) and discount rates of 0%, 3% and 5%. This way we also present a small set of sensitivities.

2. Sum of energy cost savings (compared to BAU) of the newly constructed buildings in the year of construction between 2018 and 2030, also considering energy price developments

3. Sum of mitigated emissions (compared to BAU) of the newly constructed buildings in the year of construction between 2018 and 2030

The result presents the emission abatement costs in EURO for mitigating one ton of carbon dioxide equivalent [EUR/$CO_{2e}$].

**Country specifications:**

Since Cairo comprises most of Egypt's population, the capitol of Egypt was chosen to serve as a reference climate for impact assessment modelling. Temperatures in Cairo historically range from above 5°C to about 40"C with a mean temperature of ~22°C. Also, high cooling degree days of more than 1,800 CDD compared to only 290 heating degree days indicate high cooling loads and low need for heating. The average relative humidity of 56% implies dry climate.

The buildings stock is set to grow at 2.4% per annum on average from 2018 to 2030. This leads to a residential building stock of 2,073 million m² in 2030, up from 1,438 million m² in 2015 and estimated 1,558 million m² in 2018.

### *4.2.2 Estimated Impacts*

**Energy and Emissions**

In the Business-as-usual ("BAU") scenario, specific final energy demand of new built residential housing stays constant at 54 kWh/m². The results of the impact assessment show that some of the measures discussed in chapter 4.1 can cut this to 29 kWh/m², if implemented on a stand-alone basis:

- Develop a new local Building Rating System and obligate its use for all new buildings starting by large-scale developments until reaching the smallest scale.
- Create a regulatory framework to offer incentives for project developers applying the building code and implementing EE and RE solutions e.g. reduction in cost of land, increase of built-up area, extra floor allowance, cross-subsidies, tax reductions, credit lines for soft loans at low interest rates
- Establish an energy efficiency fund to support credit guarantees and pilot project in the field of energy efficiency in residential sector
- Update permitting rules for new buildings with respect to the Egyptian energy efficiency code

Accordingly, the measures listed above also present some of the highest $CO_2$ abatement potential of all measures. If implemented as stand-alone measures, each one would save cumulated more than 20 Mt $CO_2$ in the period from 2018 to 2030. Only the measure to have accredited labs to validate the performance of the products assembled by the Egyptian industries would lead to higher $CO_2$ savings (25 Mt), while reducing specific final energy demand to 33 kWh/m².

**Investment Costs and Job Effects**

In the BAU scenario, investment cost for residential new construction is slightly increasing from EUR 1.9 billion in 2018 to EUR 2.2 billion in 2030. The four measures listed above that present the largest energy savings, consequently also significantly increase investment costs. If one of the four measures was introduced on a stand-alone basis, annual investment in 2030 would increase to around EUR 3.6 – 3.9 billion. On the other hand, each of the measures would also reduce annual energy cost by around EUR 50 million by 2030.

Increasing investment in the building stock also has an effect on employment in the sector. In the BAU scenario, employment is slightly increasing in line with rising investment volumes by a total of 1,176 jobs created by 2030. The four measures discussed in this section would however lead to significantly higher investment and therefore create 11,696 – 14,133 jobs from 2018 to 2030 each on a stand-alone basis.

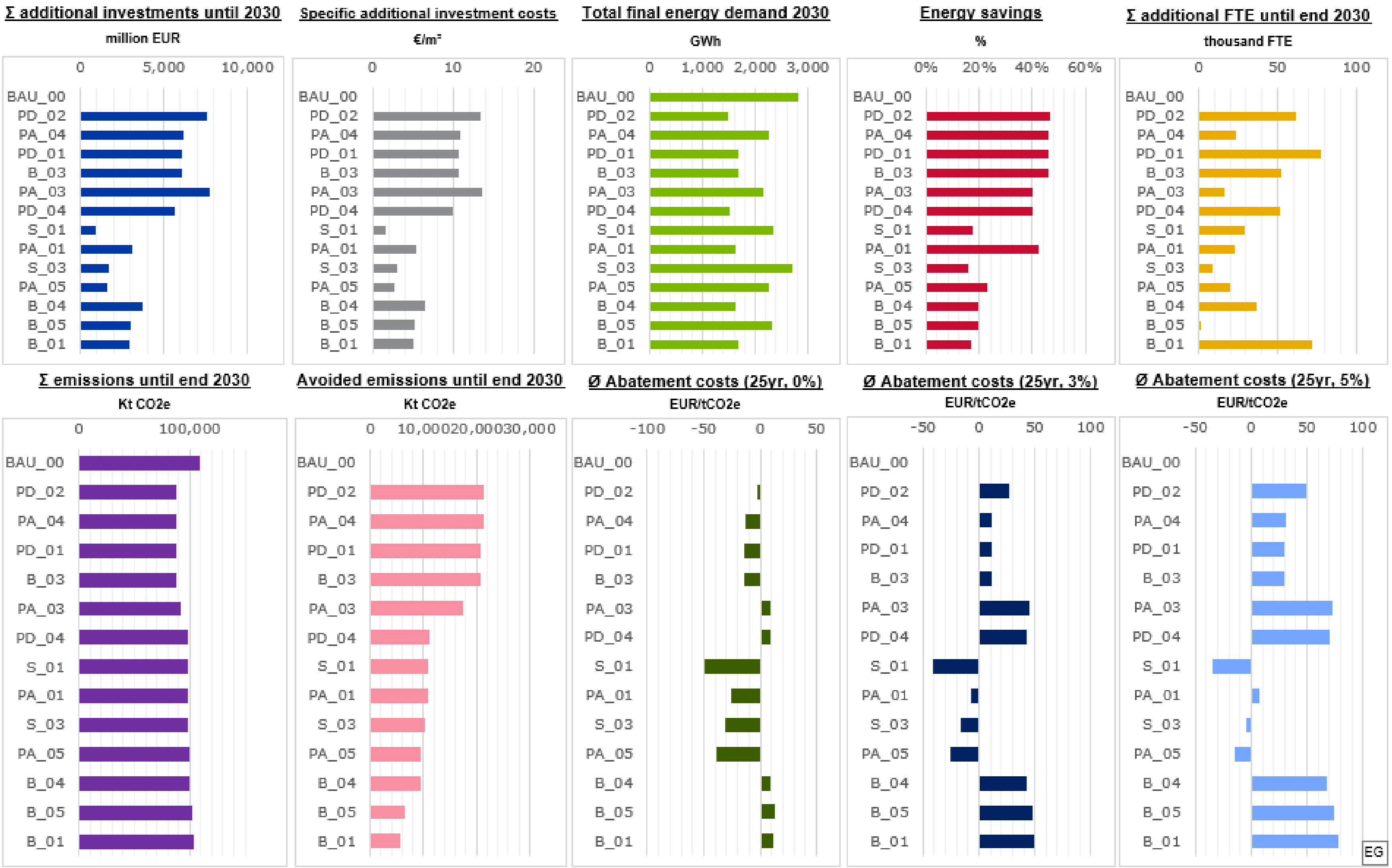



**Figure 25: Summary of estimated impacts per policy module**

# 5. KEY RECOMMENDATIONS TO BE ADDRESSED IN PHASE 2

The following table summarizes project findings for key stakeholder groups and lay down policy recommendations for accelerating energy efficiency in buildings in Egypt. These recommendations have been derived from a round of 144 interviews with key stakeholders including suppliers, 500 representative surveys with local residents and two round-table workshops conducted in Egypt with relevant stakeholders in 2017 and 2018 from the following groups:

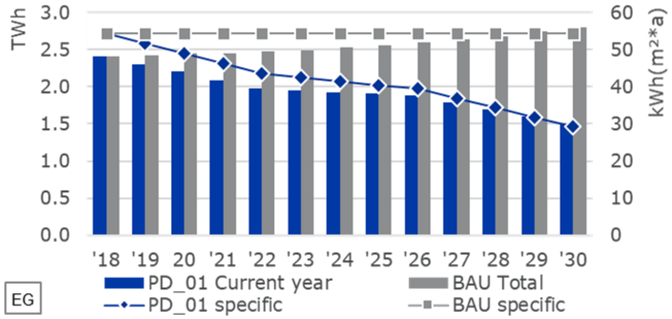
**Table 10: Summary of key recommendations in stakeholder groups**

| Stakeholder groups | Key recommendations |
|---|---|
| **Public Authorities**<br> | • Raise national awareness on fossil fuel subsidy phase out and energy efficiency<br>• Public investment in pilot projects integrating efficiency concepts in energy, food water use and waste<br>• Mandatory certification of engineers to the Egyptian Energy Efficiency Code<br>• Update of permitting rules for new buildings<br>• Strengthen enforcement in the construction phase |
| **Project Developers**<br> | • Public investment and promotion in pilot projects of energy efficient buildings<br>• Set up a regulatory framework incentivizing the application of energy efficient measures in buildings<br>• Development of a new national Building Rating System<br>• Simplify the existing energy efficiency code and strengthen enforcement<br>• Certification of engineers on rating systems and related energy efficiency codes as well as certification of energy assessors for conducting energy audits<br>• Raise the awareness of end users on potential savings and benefits of energy efficiency measures |
| **Suppliers**<br> | • Strengthen enforcement of energy efficiency standards for residential appliances<br>• Capacity building at the supplier floor level staff<br>• Accredited labs to validate the performance of products assembled by the Egyptian industries |
| **Banks**<br> | • Disseminate best practices of financing mechanisms in Egypt<br>• Disseminate best practices of MENA countries in establishing Energy Efficiency Funds<br>• Establishment of an Energy Efficiency Fund in Egypt<br>• Set up a regulatory framework for commercial banks in favour of energy efficiency funding<br>• Capacity training in Energy Efficiency Lending for bank officers |

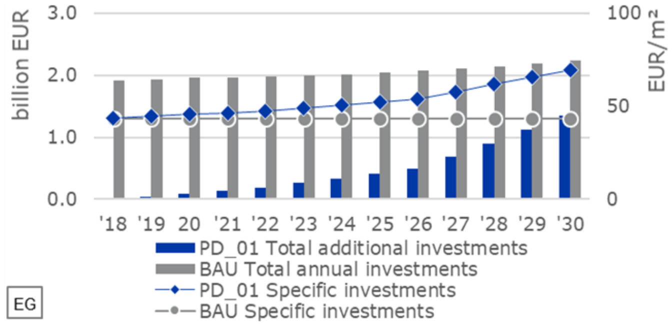
# APPENDIX A. ASSESSSED QUANTITATIVE IMPACTS OF POLICY MEASURES

The following pages show more detailed results for each developed policy measure. The results are presented in the following format:

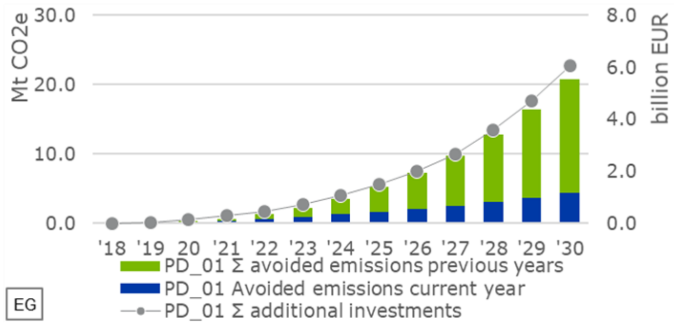
## Specific Final Energy Demand



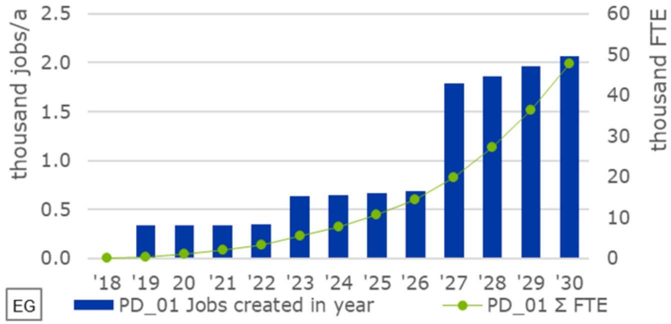

## Investment Cost



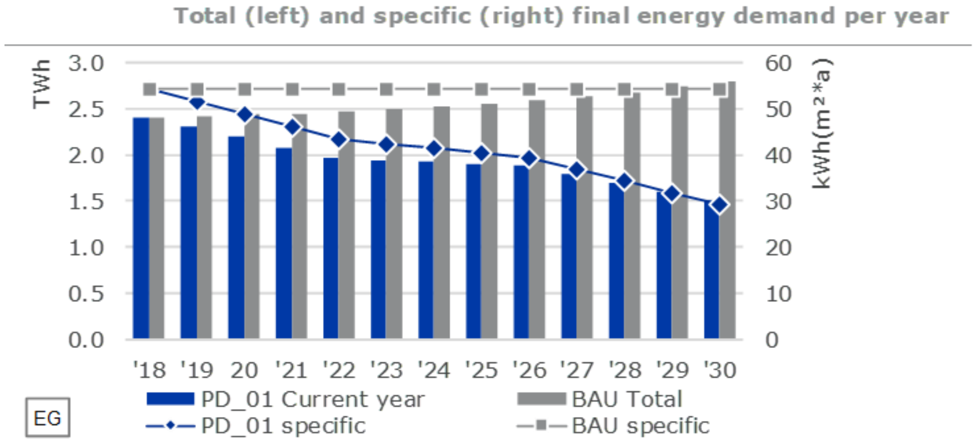

## GHG Emissions



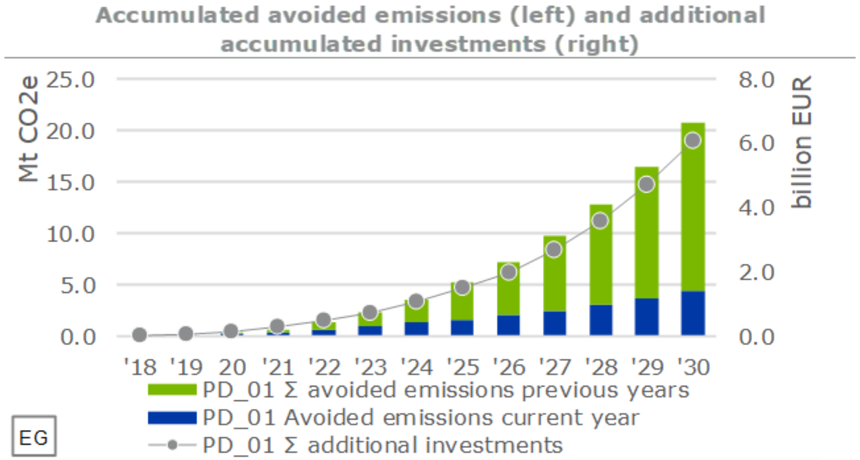

## Job Effects



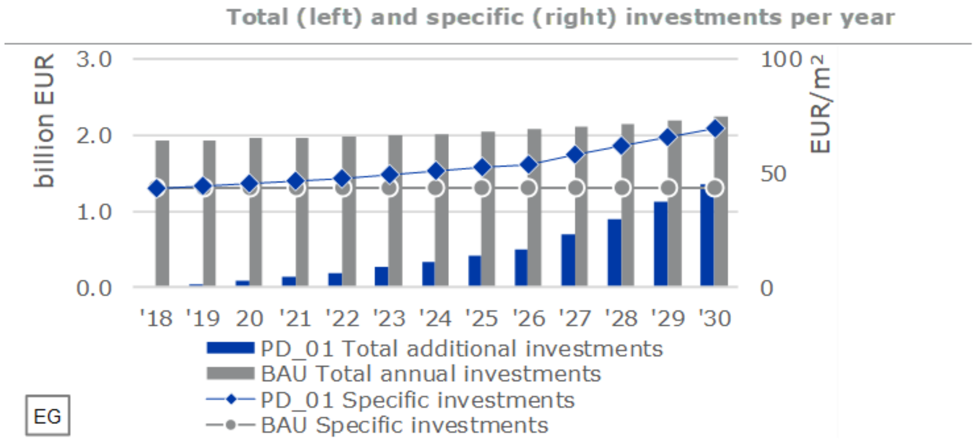
# A.1 EGY_PD_01: Impacts on energy demand, avoided emissions, investments and jobs of policy measure



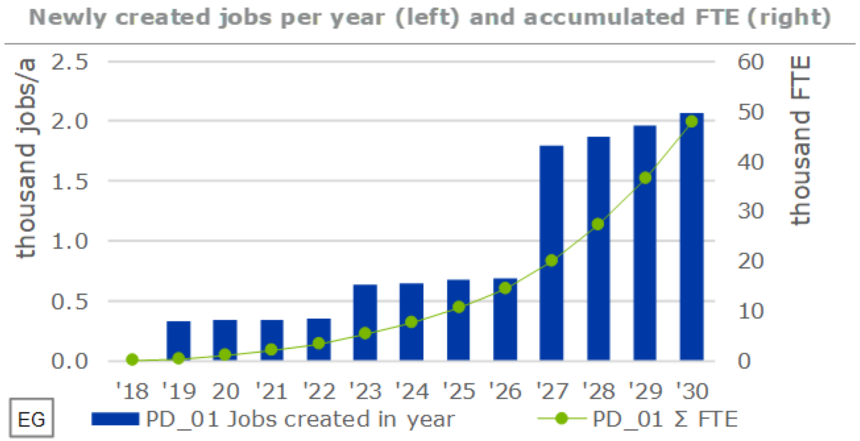

• Energy demand of new constructions can be reduced by ~46% until 2030




• ~4,340 ktCO2e can be mitigated by 2030




• Average additional investment costs between 2019-2030 are ~10 EUR/m² new building floor space




• ~11,696 jobs can be created until 2030

## ANNEX_EGY_PD_01: Assumed future technology distribution and affected shares

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 0% | 1% | 0% | 2% | 0% | 3% |
| | Gas boilers - condensing | 50% | | 40% | | 30% | |
| | Direct electricity | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 3 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 5 | 50% | | 50% | | 50% | |
| | Solar water heaters | 0% | | 10% | | 20% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 0% | 1% | 0% | 2% | 0% | 3% |
| | Fossil - efficient | 0% | | 0% | | 0% | |
| | Electric | 0% | | 0% | | 0% | |
| | Solar water heaters | 100% | | 100% | | 100% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 0% | 1% | 0% | 2% | 0% | 3% |
| | Mechanical ventilation w heat recovery 50% | 0% | | 0% | | 0% | |
| | Mechanical ventilation w heat recovery 90% | 100% | | 100% | | 100% | |
| Space cooling technologies | AC or Chillers COP > 4 | ++ | 1% | ++ | 2% | ++ | 3% |
| Windows | | ++ | 1% | ++ | 2% | ++ | 3% |
| Infiltration rate | | ++ | 1% | ++ | 2% | ++ | 3% |
| Insulation Thickness | Facade | ++ | 1% | ++ | 2% | ++ | 3% |
| | Rooftop | ++ | 1% | ++ | 2% | ++ | 3% |
| | Ground | ++ | 1% | ++ | 2% | ++ | 3% |
| Shadowing measures (window shading) | | ++ | 1% | ++ | 2% | ++ | 3% |

NAVIGANT
A Guidehouse Company

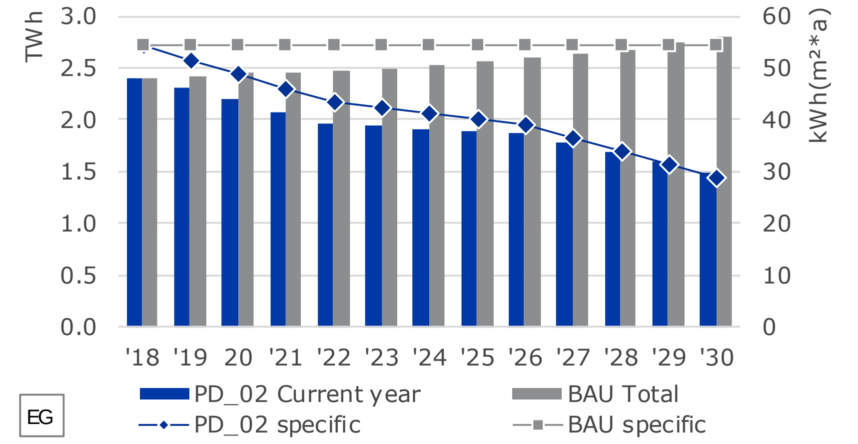
Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

INTERNATIONALE KLIMASCHUTZINITIATIVE (IKI)

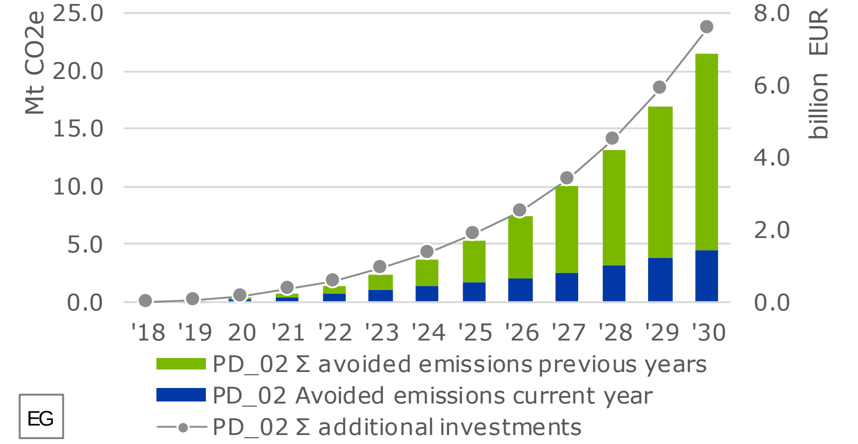
## A.2 EGY_PD_02: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

### Total (left) and specific (right) final energy demand per year



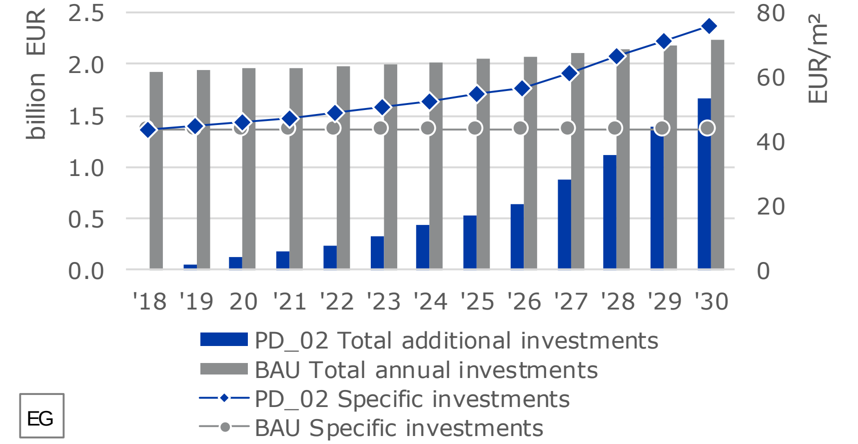

- Energy demand of new constructions can be reduced by ~47% until 2030

### Accumulated avoided emissions (left) and additional accumulated investments (right)



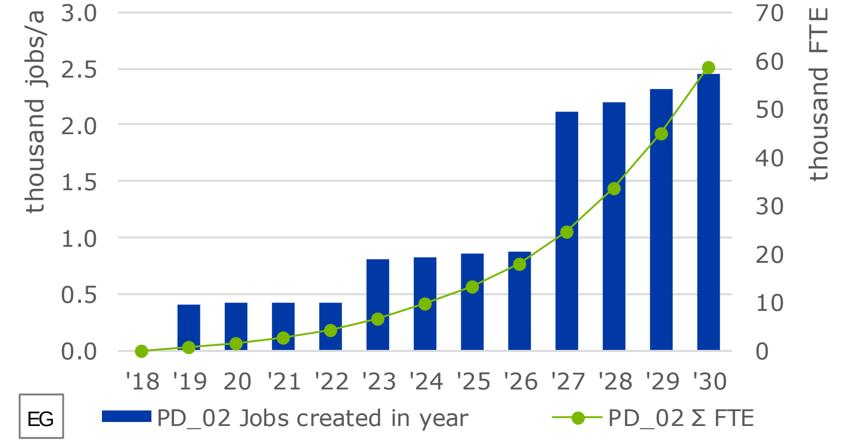

- ~4,500 ktCO2e can be mitigated by 2030

### Total (left) and specific (right) investments per year




- Average additional investment costs between 2019-2030 are ~13 EUR/m² new building floor space

### Newly created jobs per year (left) and accumulated FTE (right)




- ~14,133 jobs can be created until 2030

**ANNEX_EGY _PD_02: Assumed future technology distribution and affected shares**

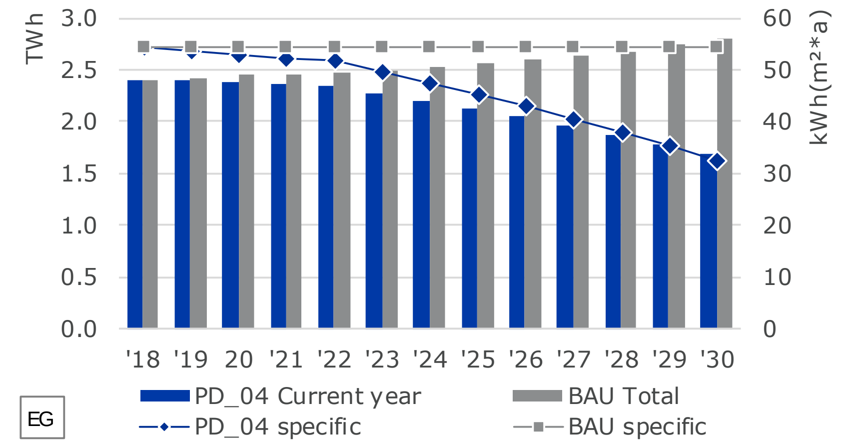
| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 10% | 15% | 5% | 23% | 0% | 30% |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 10% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 35% | 45% | 15% | 45% | 0% | 45% |
| | Fossil - efficient | 10% | | 25% | | 35% | |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | 37.5% | 75% | 45% | 60% | 60% |
| | Mechanical ventilation w heat recovery 50% | 7% | | 15% | | 20% | |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | + | 50% | + | 60% | ++ | 70% |
| Windows | | + | 25% | + | 38% | ++ | 56% |
| Infiltration rate | | o | 10% | + | 20% | ++ | 30% |
| Insulation Thickness | Facade | + | 20% | + | 40% | ++ | 60% |
| | Rooftop | + | 70% | + | 77% | ++ | 85% |
| | Ground | + | 70% | + | 77% | ++ | 85% |
| Shadowing measures (window shading) | | o | 20% | + | 30% | ++ | 40% |

## A.3 EGY _PD_03: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

*No quantified impact assessment available*

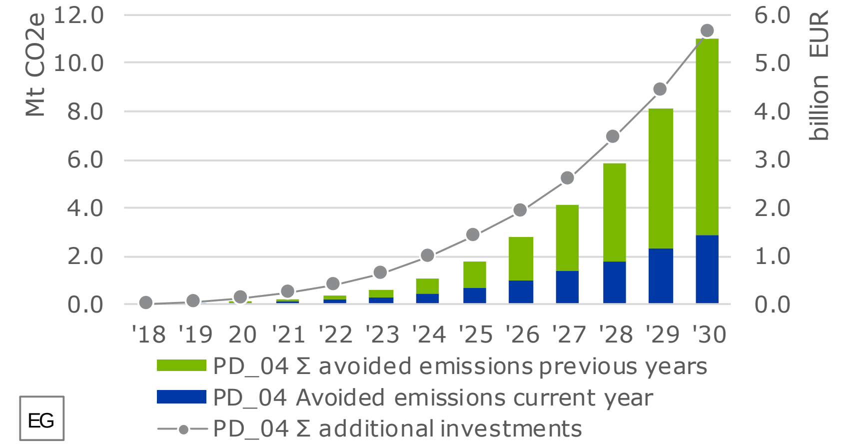
## A.4 EGY _PD_04: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

Total (left) and specific (right) final energy demand per year



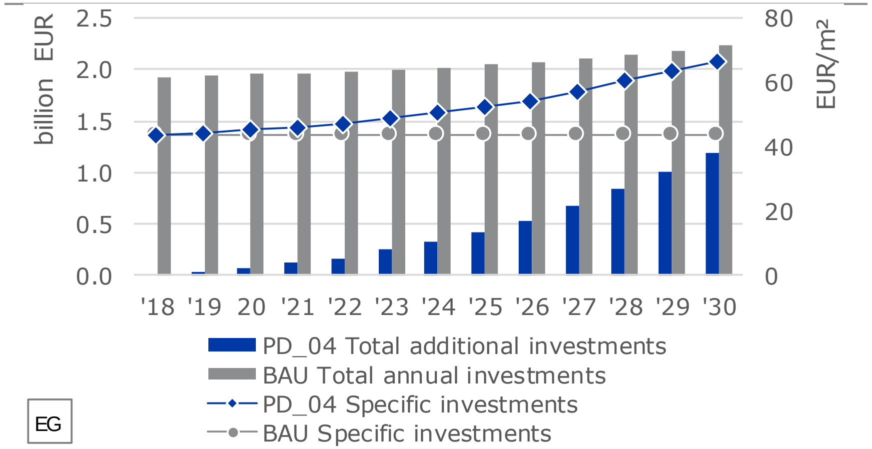

• **Energy demand of new constructions can be reduced by ~40% until 2030**

Accumulated avoided emissions (left) and additional accumulated investments (right)



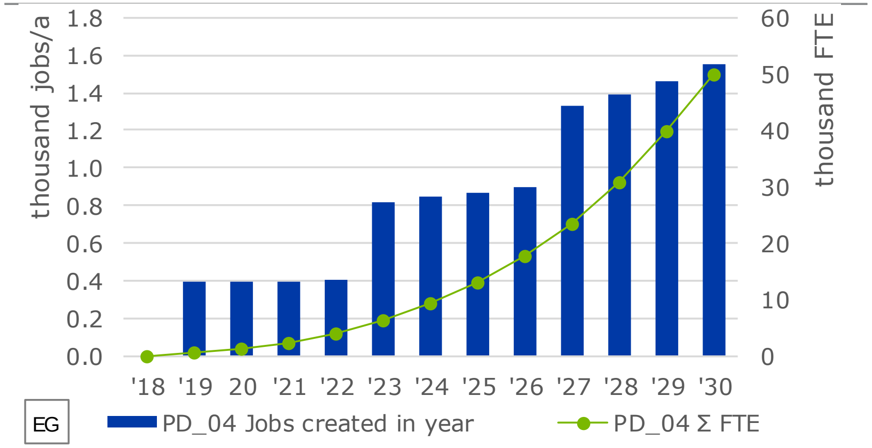

• **~2,870 ktCO2e can be mitigated by 2030**

Total (left) and specific (right) investments per year




• **Average additional investment costs between 2019-2030 are ~10 EUR/m² new building floor space**

Newly created jobs per year (left) and accumulated FTE (right)

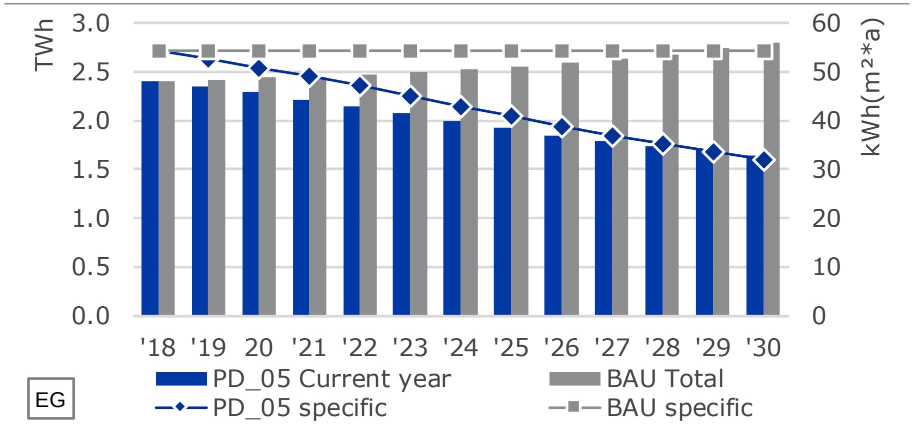



• **~10,755 jobs can be created until 2030**

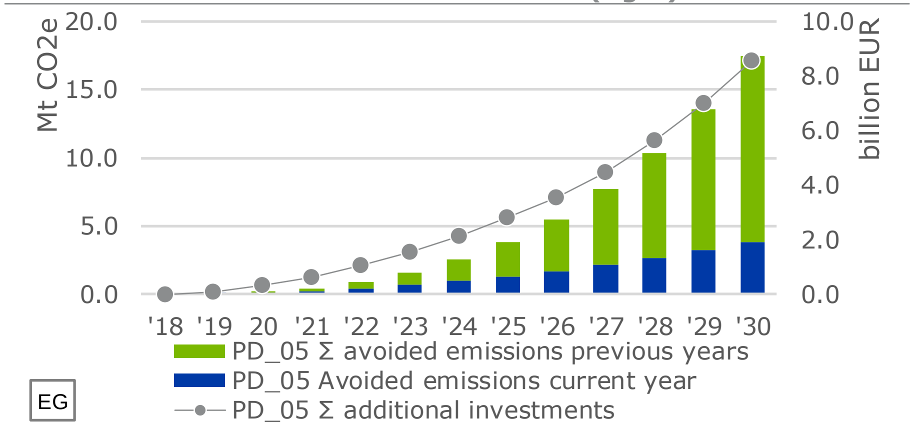
**ANNEX_EGY _PD_04: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 0% | 3% | 0% | 11% | 0% | 20% |
| | Gas boilers - condensing | 30% | | 30% | | 30% | |
| | Direct electricity | 30% | | 30% | | 30% | |
| | Heat Pumps (any source) - COP 3 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 20% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 20% | | 20% | | 20% | |
| | Solar water heaters | 0% | | 0% | | 0% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 0% | 9% | 0% | 11% | 0% | 20% |
| | Fossil - efficient | 33% | | 33% | | 33% | |
| | Electric | 33% | | 33% | | 33% | |
| | Solar water heaters | 34% | | 34% | | 34% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 35% | 7.5% | 35% | 21% | 35% | 40% |
| | Mechanical ventilation w heat recovery 50% | 35% | | 35% | | 35% | |
| | Mechanical ventilation w heat recovery 90% | 30% | | 30% | | 30% | |
| Space cooling technologies | AC or Chillers COP > 4 | o | 15% | + | 42% | ++ | 70% |
| Windows | | + | 7.5% | + | 26% | + | 56% |
| Infiltration rate | | + | 3% | + | 14% | + | 30% |
| Insulation Thickness | Facade | + | 6% | + | 28% | + | 60% |
| | Rooftop | + | 21% | + | 53% | + | 85% |
| | Ground | + | 21% | + | 53% | + | 85% |
| Shadowing measures (window shading) | | + | 6% | + | 21% | + | 40% |

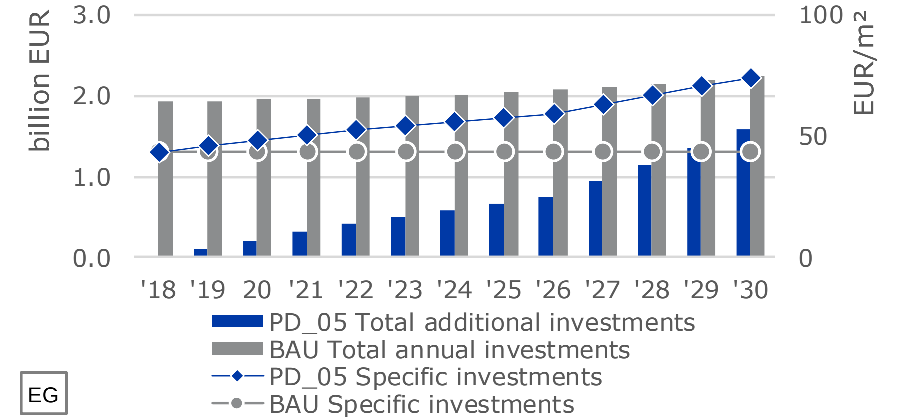
## A.5 EGY_PD_05: Impacts on energy demand, avoided emissions, investments and jobs of policy measure



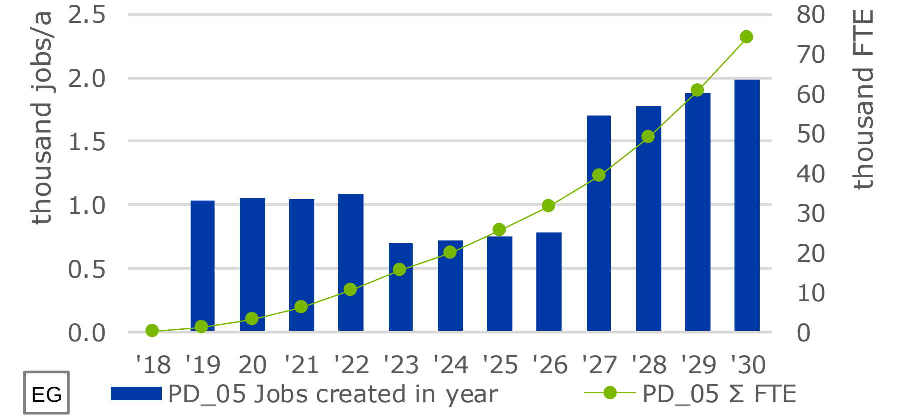

- **Energy demand of new constructions can be reduced by ~41% until 2030**




- **~3,840 ktCO2e can be mitigated by 2030**



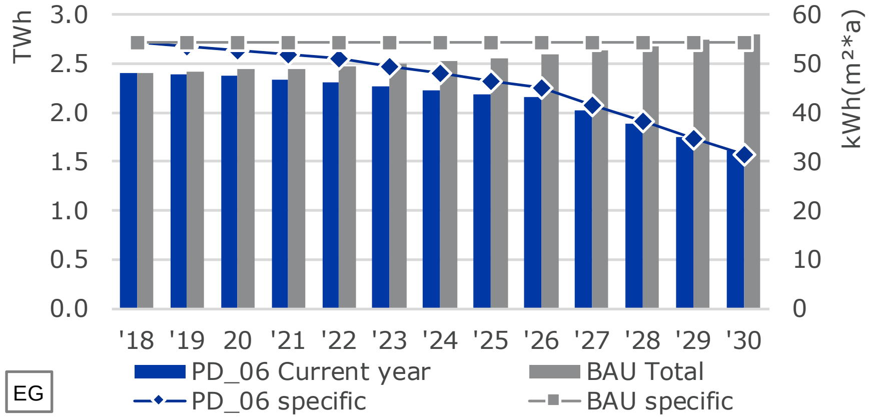

- **Average additional investment costs between 2019-2030 are ~15 EUR/m² new building floor space**




- **~14,517 jobs can be created until 2030**

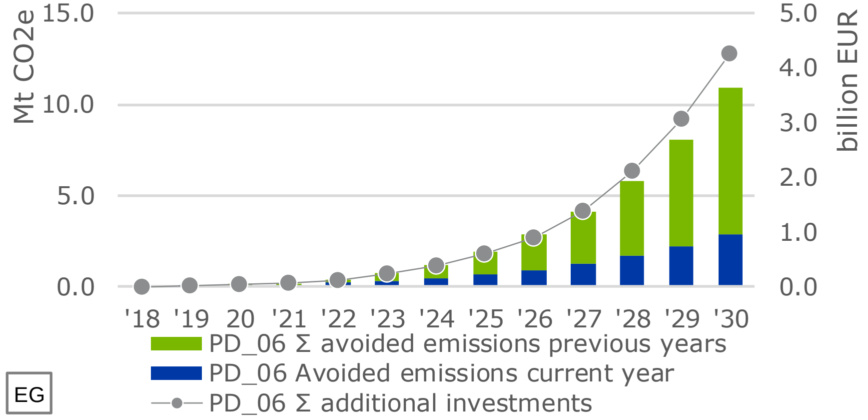
# A.6 EGY_PD_06: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

**Total (left) and specific (right) final energy demand per year**



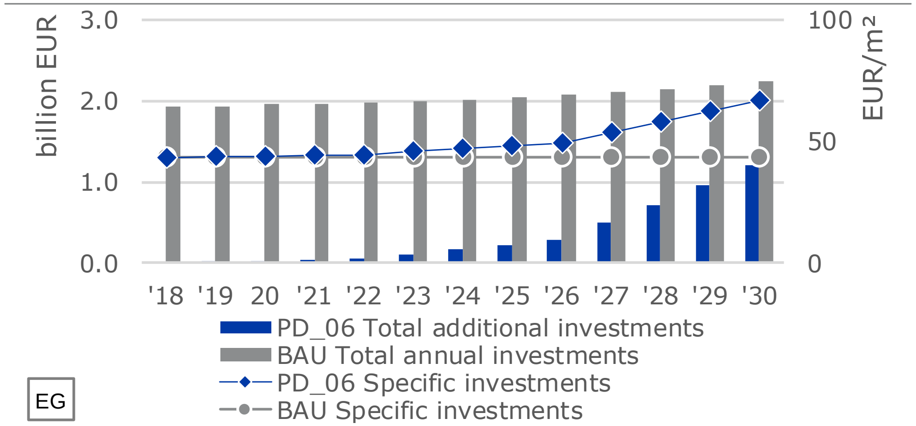

- **Energy demand of new constructions can be reduced by ~42% until 2030**

**Accumulated avoided emissions (left) and additional accumulated investments (right)**



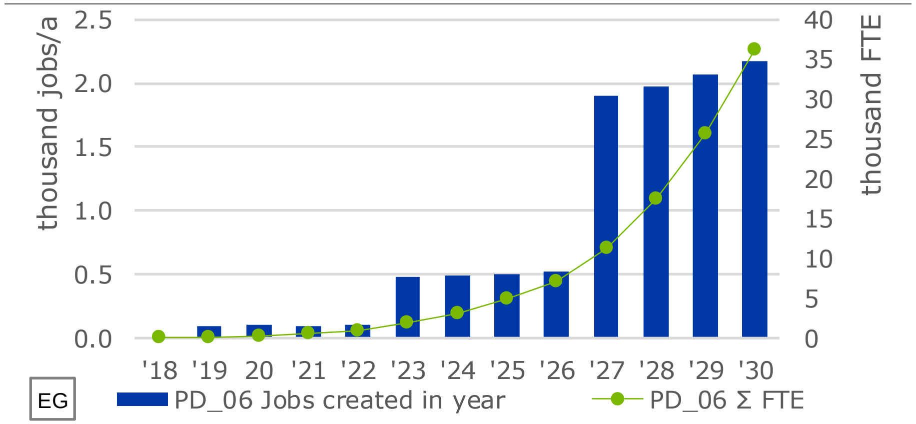

- **~2,880 ktCO2e can be mitigated by 2030**

**Total (left) and specific (right) investments per year**




- **Average additional investment costs between 2019-2030 are ~7 EUR/m² new building floor space**

**Newly created jobs per year (left) and accumulated FTE (right)**

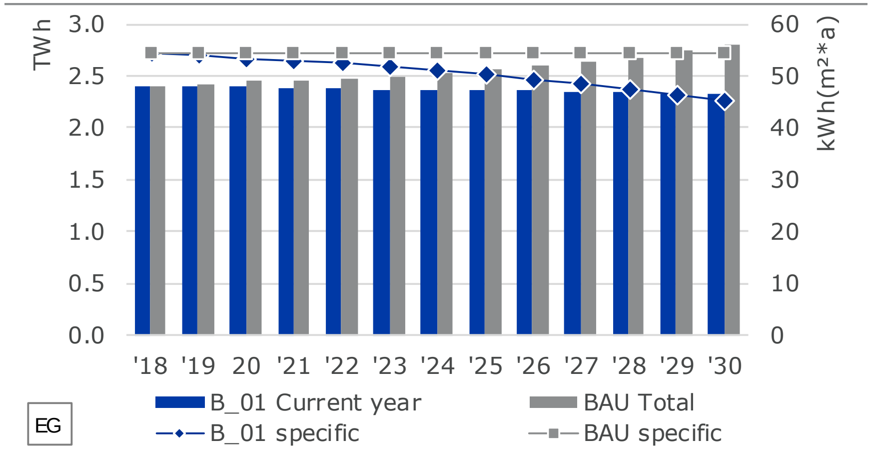



- **~10,492 jobs can be created until 2030**

# A.7 EGY_B_01: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

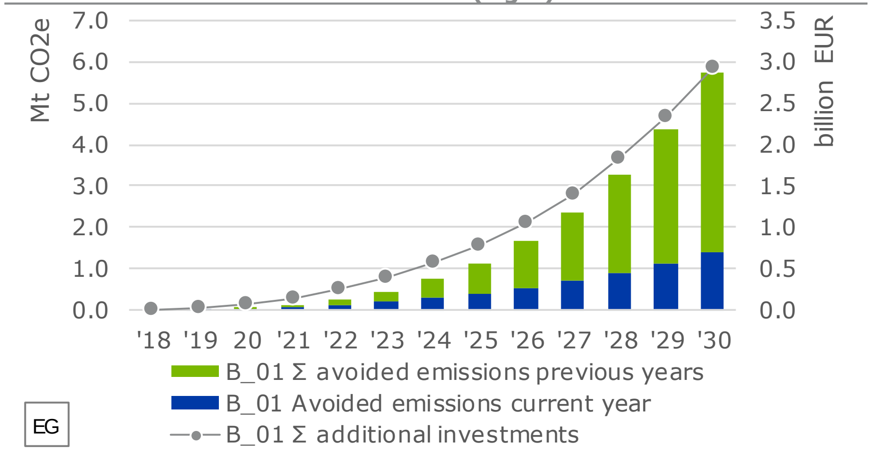
.

Total (left) and specific (right) final energy demand per year



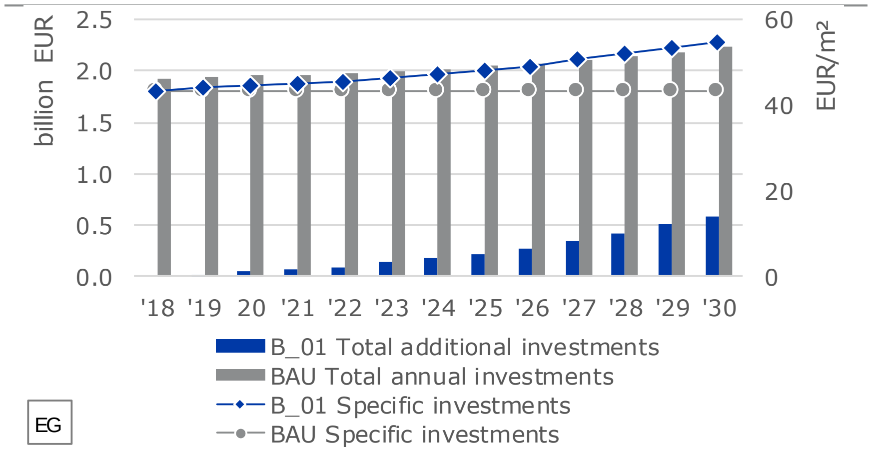

• **Energy demand of new constructions can be reduced by ~17% until 2030**

Accumulated avoided emissions (left) and additional accumulated investments (right)



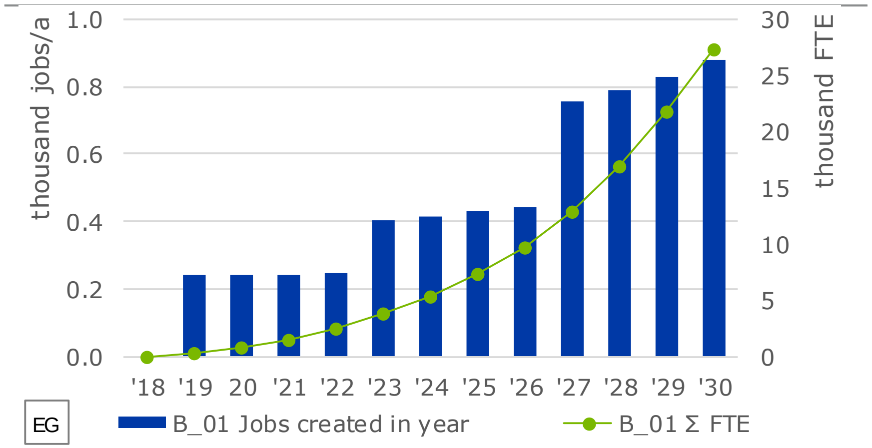

• **~1,370 ktCO2e can be mitigated by 2030**

Total (left) and specific (right) investments per year




• **Average additional investment costs between 2019-2030 are ~5 EUR/m² new building floor space**

Newly created jobs per year (left) and accumulated FTE (right)




• **~5,918 jobs can be created until 2030**

**ANNEX_EGY _B_01: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | | | | | | |
| | Gas boilers - condensing | 50% | | 50% | | 50% | |
| | Direct electricity | | | | | | |
| | Heat Pumps (any source) - COP 3 | | | | | | |
| | Heat Pumps (any source) - COP 4 | | 1% | | 3% | | 6% |
| | Heat Pumps (any source) - COP 5 | 50% | | 50% | | 50% | |
| | Solar water heaters | | | | | | |
| | Biomass boilers - conventional | | | | | | |
| | Biomass boilers - efficient | | | | | | |
| Water heating technologies | Fossil - conventional | | | | | | |
| | Fossil - efficient | | 3% | | 6% | | 9% |
| | Electric | | | | | | |
| | Solar water heaters | 100% | | 100% | | 100% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | | | | | | |
| | Mechanical ventilation w heat recovery 50% | | 2.5% | | 6% | | 12% |
| | Mechanical ventilation w heat recovery 90% | 100% | | 100% | | 100% | |
| Space cooling technologies | AC or Chillers COP > 4 | ++ | 5% | ++ | 12% | ++ | 21% |
| Windows | | ++ | 2.5% | ++ | 7.5% | ++ | 16.875% |
| Infiltration rate | | ++ | 1% | ++ | 4% | ++ | 9% |
| Insulation Thickness | Facade | ++ | 2% | ++ | 8% | ++ | 18% |
| | Rooftop | ++ | 7% | ++ | 15.4% | ++ | 25.41% |
| | Ground | ++ | 7% | ++ | 15.4% | ++ | 25.41% |
| Shadowing measures (window shading) | | ++ | 2% | ++ | 6% | ++ | 12% |

## A.8 EGY_B_02: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

*No quantified impact assessment available*

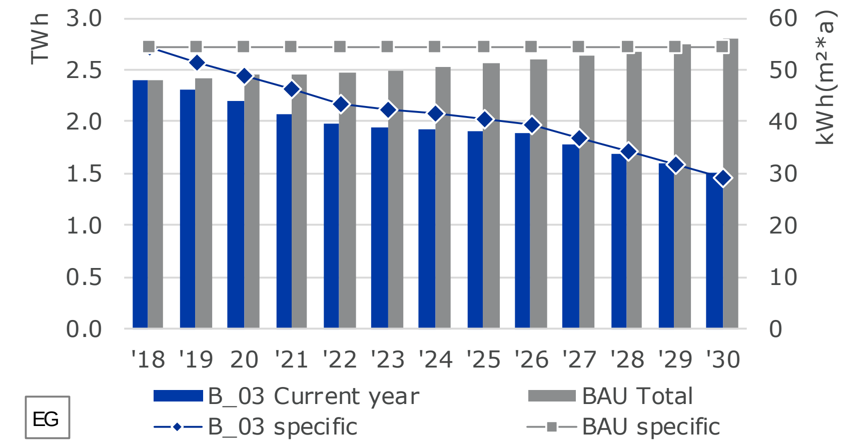
Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

INTERNATIONALE KLIMASCHUTZINITIATIVE (IKI)

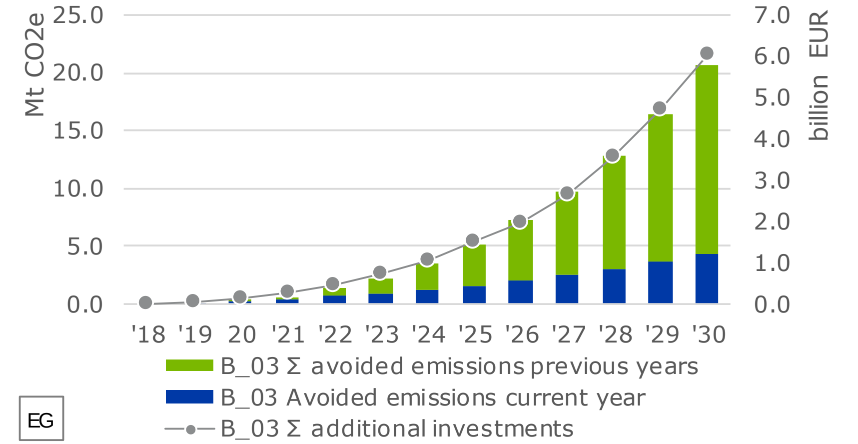
## A.9 EGY_B_03: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

Total (left) and specific (right) final energy demand per year



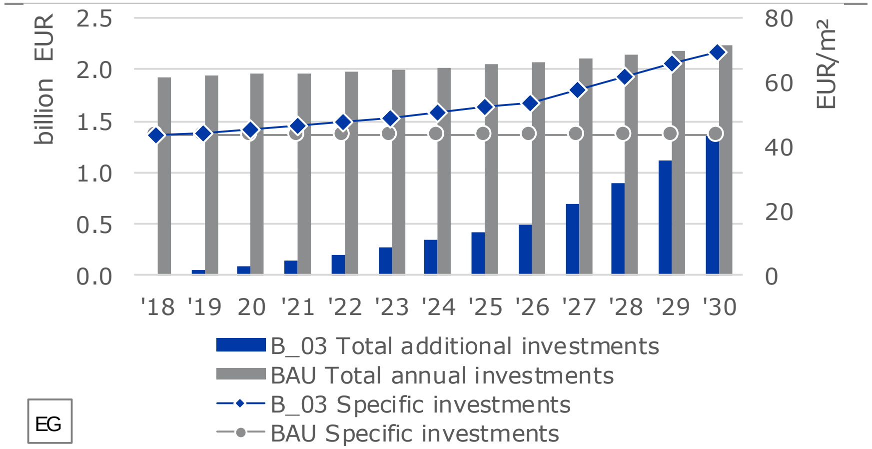

• **Energy demand of new constructions can be reduced by ~46% until 2030**

Accumulated avoided emissions (left) and additional accumulated investments (right)



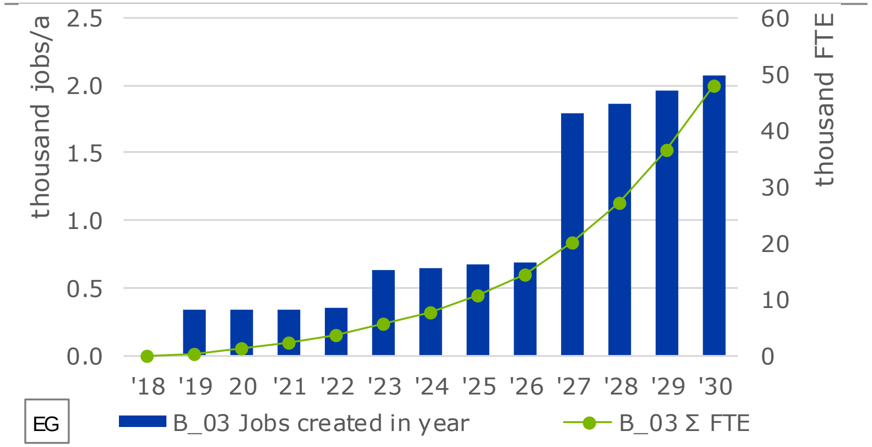

• **~4,340 ktCO2e can be mitigated by 2030**

Total (left) and specific (right) investments per year




• **Average additional investment costs between 2019-2030 are ~10 EUR/m² new building floor space**

Newly created jobs per year (left) and accumulated FTE (right)



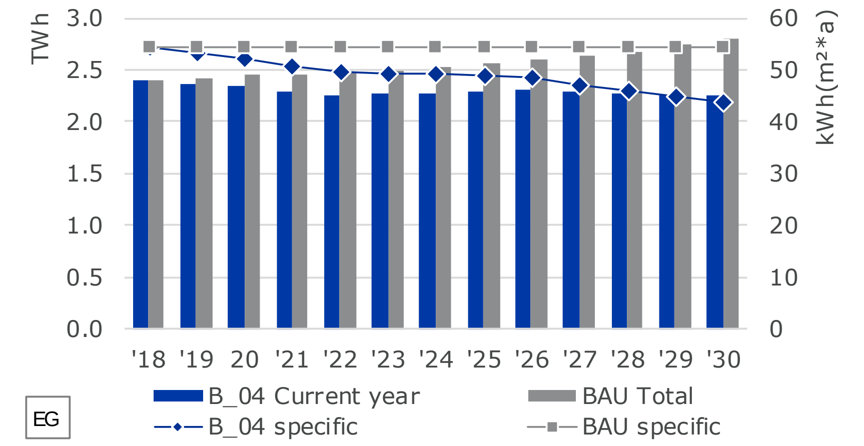

• **~11,696 jobs can be created until 2030**

## ANNEX_EGY_B_03: Assumed future technology distribution and affected shares

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| | Gas boilers - conventional | 10% | | 5% | | 0% | |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| Space heating technologies | Heat Pumps (any source) - COP 4 | 10% | 10% | 20% | 15% | 20% | 20% |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| | Fossil - conventional | 35% | | 15% | | 0% | |
| Water heating technologies | Fossil - efficient | 10% | 30% | 25% | 30% | 35% | 30% |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | | 75% | | 60% | |
| Mechanical Ventilation | Mechanical ventilation w heat recovery 50% | 7% | 25% | 15% | 30% | 20% | 40% |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | + | 50% | + | 60% | ++ | 70% |
| Windows | | + | 25% | + | 37.5% | ++ | 57% |
| Infiltration rate | | o | 10% | + | 20% | ++ | 30% |
| | Facade | + | 20% | + | 40% | ++ | 60% |
| Insulation Thickness | Rooftop | + | 70% | + | 77% | ++ | 85% |
| | Ground | + | 70% | + | 77% | ++ | 85% |
| Shadowing measures (window shading) | | o | 20% | + | 30% | ++ | 40% |

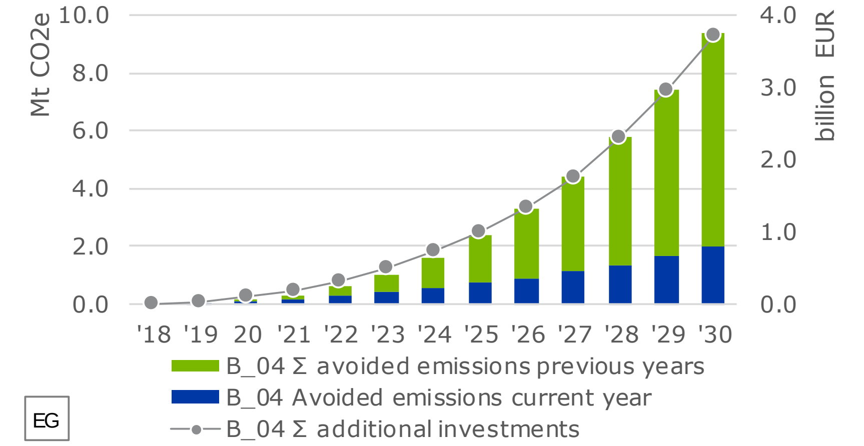
# A.10 EGY_B_04: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

Total (left) and specific (right) final energy demand per year



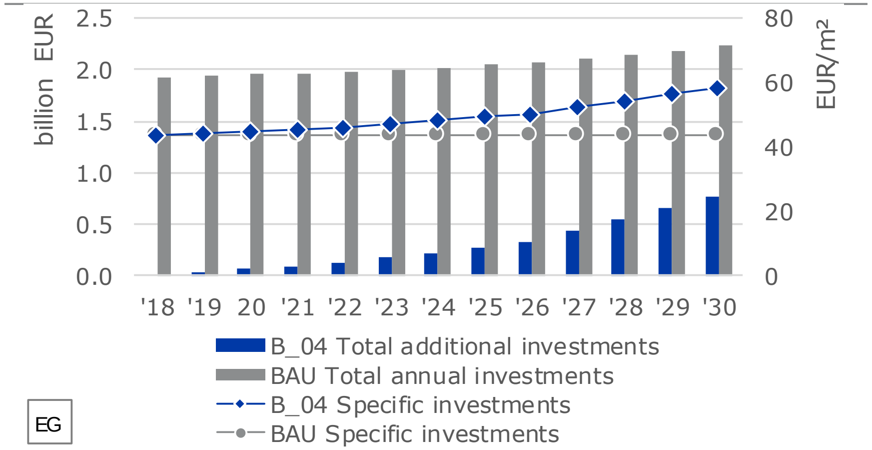

• **Energy demand of new constructions can be reduced by ~20% until 2030**

Accumulated avoided emissions (left) and additional accumulated investments (right)



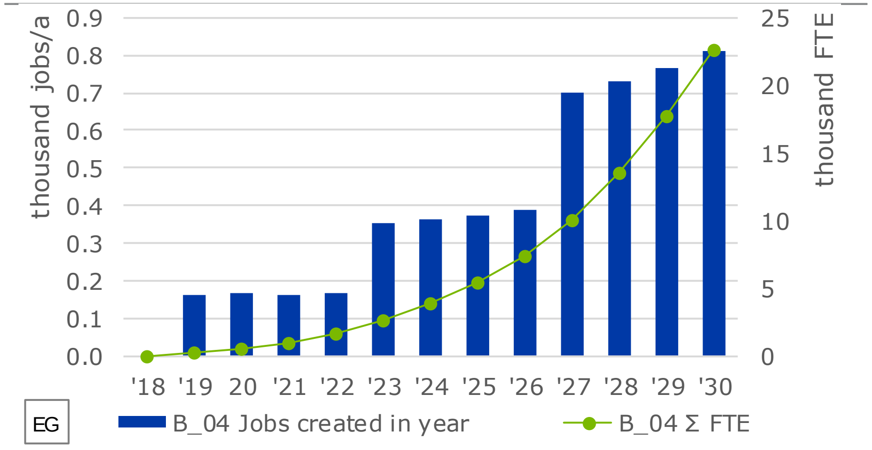

• **~1,990 ktCO2e can be mitigated by 2030**

Total (left) and specific (right) investments per year




• **Average additional investment costs between 2019-2030 are ~6 EUR/m² new building floor space**

Newly created jobs per year (left) and accumulated FTE (right)



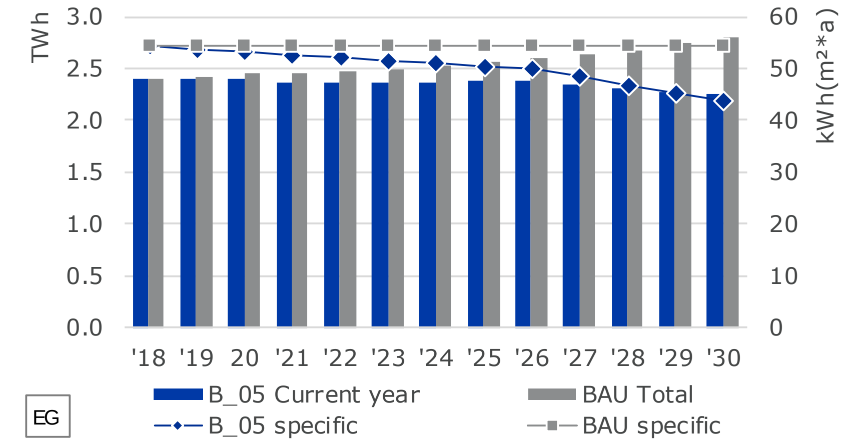

• **~5,140 jobs can be created until 2030**

**ANNEX_EGY_B_04: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 10% | 10% | 5% | 15% | 0% | 20% |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 10% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 35% | 30% | 15% | 30% | 0% | 30% |
| | Fossil - efficient | 10% | | 25% | | 35% | |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | 25% | 75% | 30% | 60% | 40% |
| | Mechanical ventilation w heat recovery 50% | 7% | | 15% | | 20% | |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | + | 50% | + | 60% | ++ | 70% |
| Windows | | o | 25% | o | 37.5% | o | 56.25% |
| Infiltration rate | | o | 10% | o | 20% | o | 30% |
| Insulation Thickness | Facade | o | 20% | o | 40% | o | 60% |
| | Rooftop | o | 70% | o | 77% | o | 84.7% |
| | Ground | o | 70% | o | 77% | o | 84.7% |
| Shadowing measures (window shading) | | o | 20% | o | 30% | o | 40% |

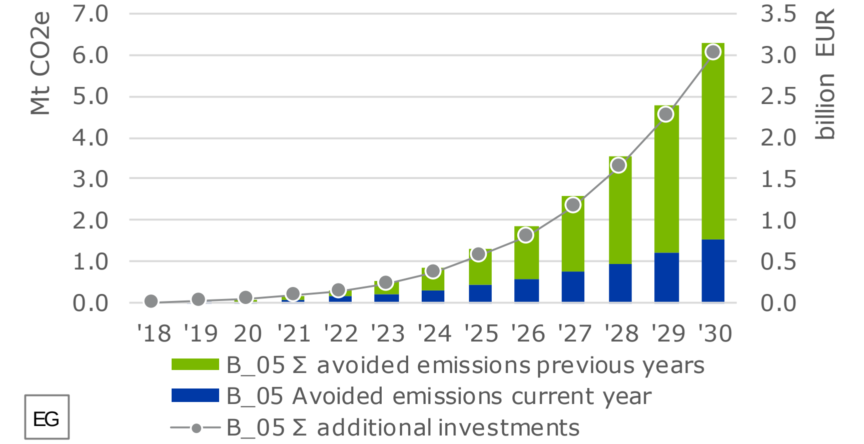
# A.11 EGY_B_05: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

Total (left) and specific (right) final energy demand per year



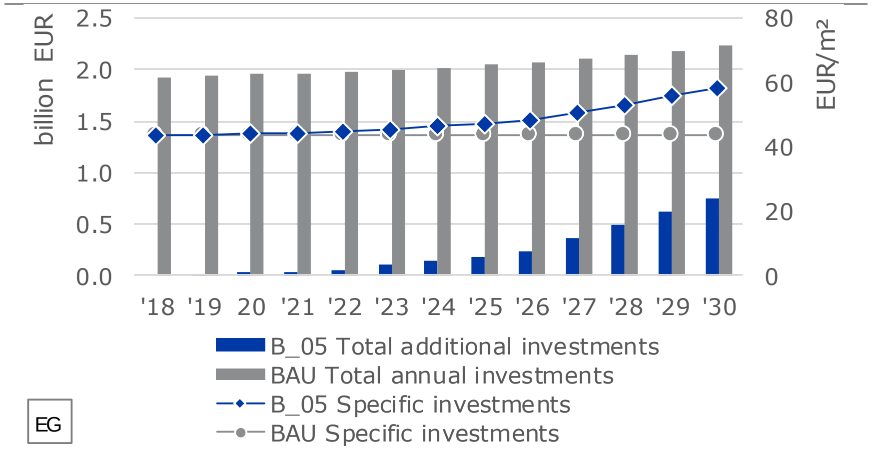

• **Energy demand of new constructions can be reduced by ~20% until 2030**

Accumulated avoided emissions (left) and additional accumulated investments (right)



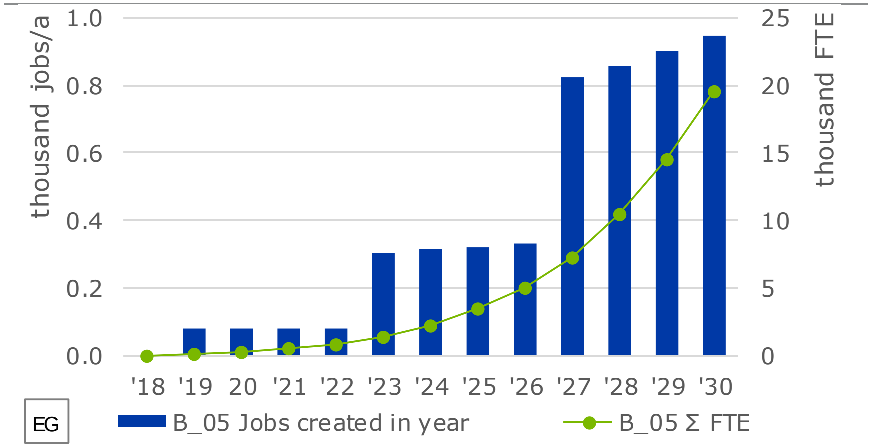

• **~1,540 ktCO2e can be mitigated by 2030**

Total (left) and specific (right) investments per year




• **Average additional investment costs between 2019-2030 are ~5 EUR/m² new building floor space**

Newly created jobs per year (left) and accumulated FTE (right)



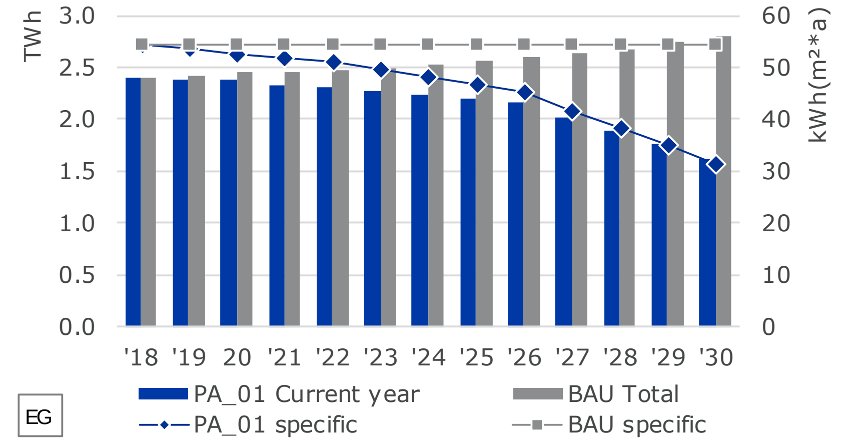

• **~5,110 jobs can be created until 2030**

**ANNEX_EGY_B_05: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 10% | 5% | 5% | 11.25% | 0% | 20% |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 10% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 35% | 15% | 15% | 22.5% | 0% | 20% |
| | Fossil - efficient | 10% | | 25% | | 35% | |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | 12.5% | 75% | 22.5% | 60% | 40% |
| | Mechanical ventilation w heat recovery 50% | 7% | | 15% | | 20% | |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | + | 25% | + | 45% | ++ | 70% |
| Windows | | o | 12.5% | o | 28.125% | o | 56.25% |
| Infiltration rate | | o | 5% | o | 15% | o | 30% |
| Insulation Thickness | Facade | o | 10% | o | 30% | o | 60% |
| | Rooftop | o | 35% | o | 57.75% | o | 84.7% |
| | Ground | o | 35% | o | 57.75% | o | 84.7% |
| Shadowing measures (window shading) | | o | 10% | o | 22.5% | o | 40% |

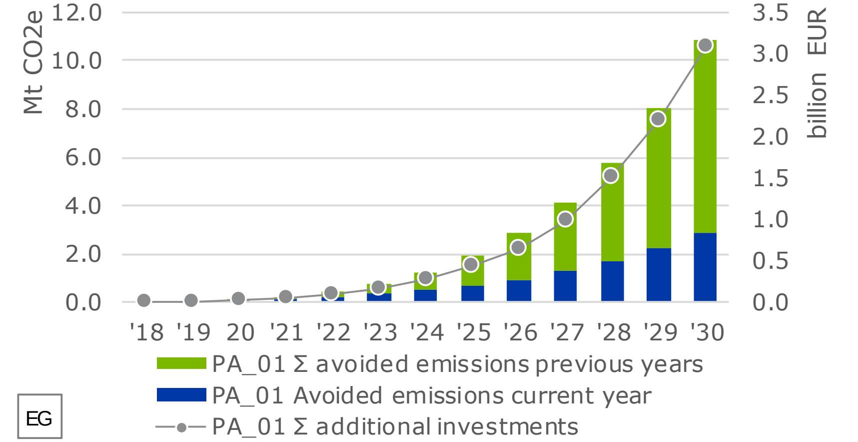
# A.12 EGY_PA_01: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

## Total (left) and specific (right) final energy demand per year



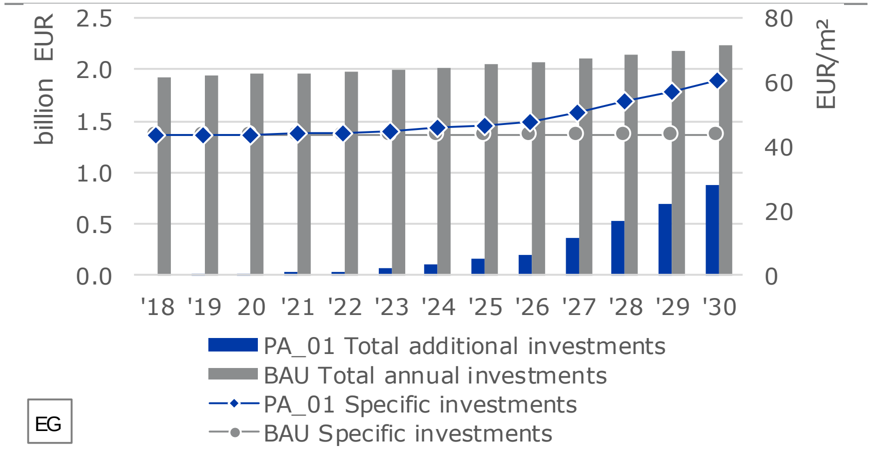

• **Energy demand of new constructions can be reduced by ~42% until 2030**

## Accumulated avoided emissions (left) and additional accumulated investments (right)



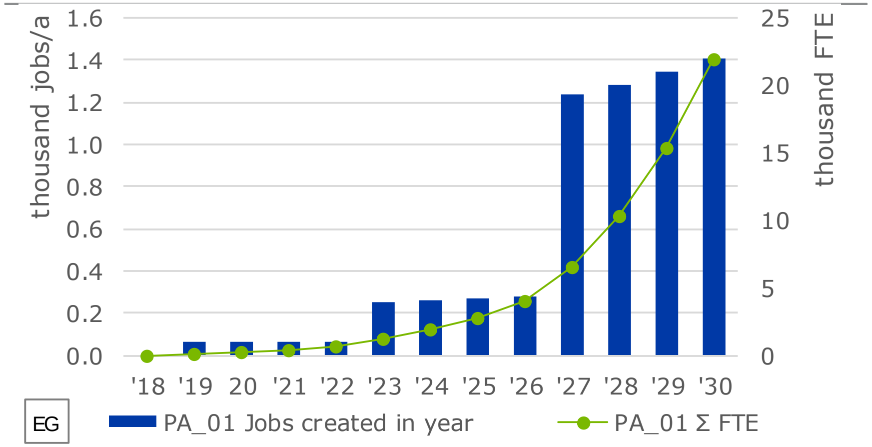

• **~2,860 ktCO2e can be mitigated by 2030**

## Total (left) and specific (right) investments per year




• **Average additional investment costs between 2019-2030 are ~5 EUR/m² new building floor space**

## Newly created jobs per year (left) and accumulated FTE (right)

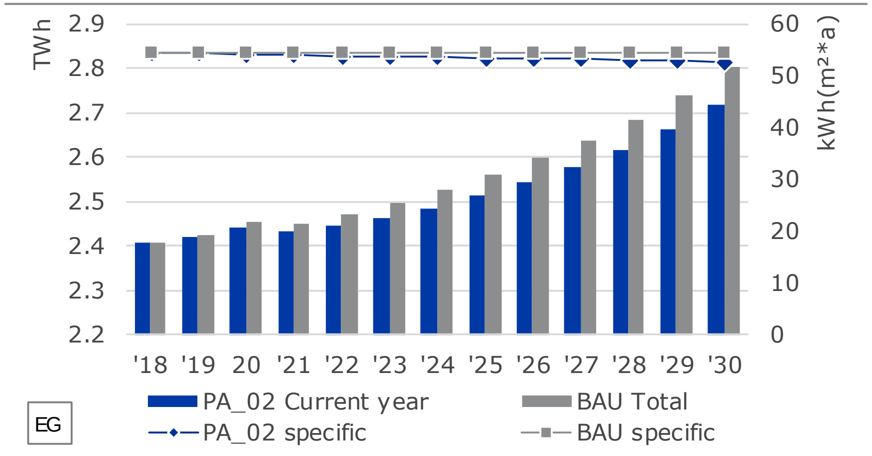



• **~6,572 jobs can be created until 2030**

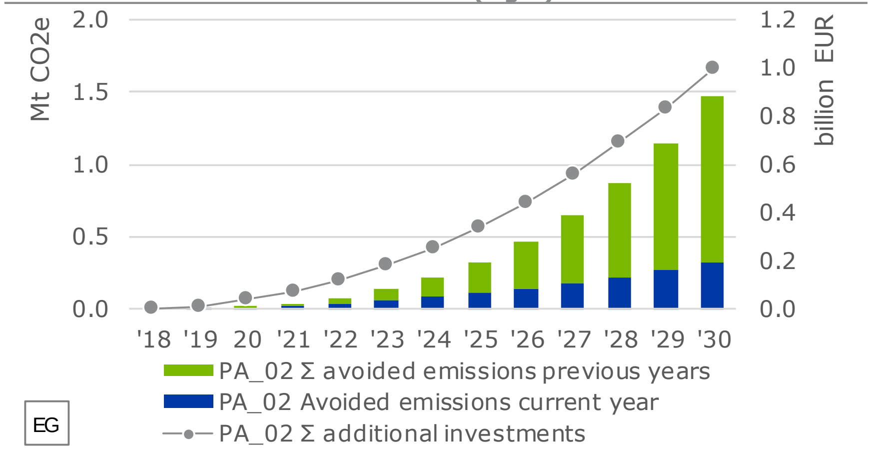
## ANNEX_EGY_PA_01: Assumed future technology distribution and affected shares

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 10% | 3% | 5% | 9% | 0% | 18% |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 10% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 35% | 9% | 15% | 18% | 0% | 27% |
| | Fossil - efficient | 10% | | 25% | | 35% | |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | 0% | 75% | 0% | 60% | 0% |
| | Mechanical ventilation w heat recovery 50% | 7% | | 15% | | 20% | |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | + | 15% | + | 36% | ++ | 63% |
| Windows | | + | 7.5% | + | 22.5% | ++ | 50.625% |
| Infiltration rate | | o | 3% | + | 12% | ++ | 27% |
| Insulation Thickness | Facade | + | 6% | + | 24% | ++ | 54% |
| | Rooftop | + | 21% | + | 46.2% | ++ | 76.23% |
| | Ground | + | 21% | + | 46.2% | ++ | 76.23% |
| Shadowing measures (window shading) | | o | 6% | + | 18% | ++ | 36% |

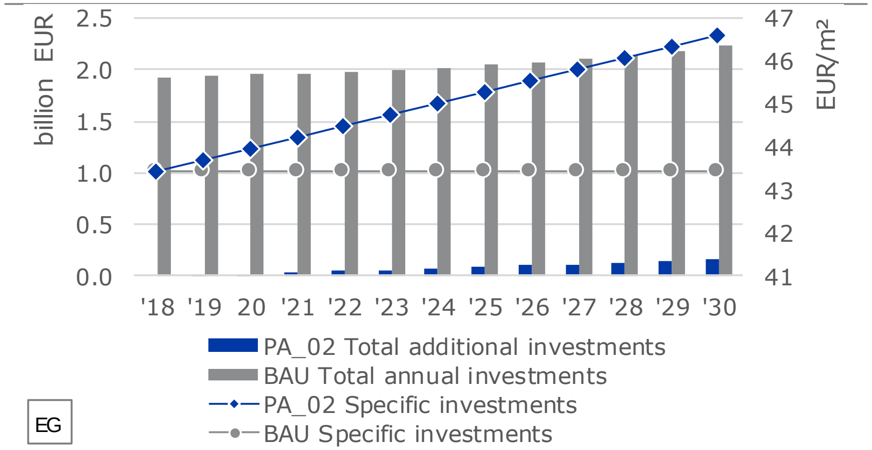
# A.13 EGY_PA_02: Impacts on energy demand, avoided emissions, investments and jobs of policy measure



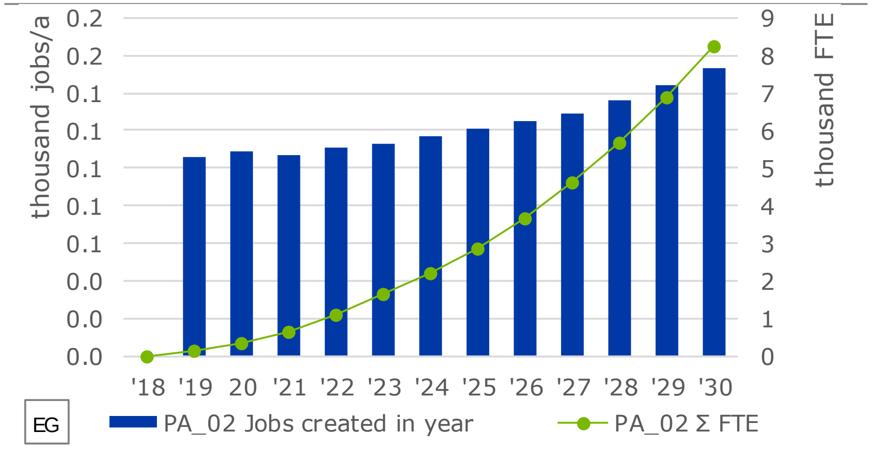

- **Energy demand of new constructions can be reduced by ~3% until 2030**




- **~320 ktCO2e can be mitigated by 2030**




- **Average additional investment costs between 2019-2030 are ~2 EUR/m² new building floor space**



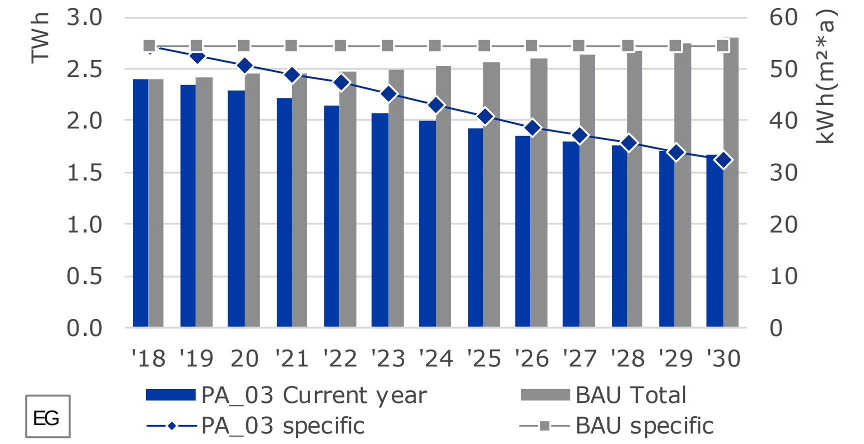

- **~1,472 jobs can be created until 2030**

**ANNEX_EGY_PA_02: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 0% | 1% | 0% | 2% | 0% | 3% |
| | Gas boilers - condensing | 50% | | 40% | | 30% | |
| | Direct electricity | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 3 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 5 | 50% | | 50% | | 50% | |
| | Solar water heaters | 0% | | 10% | | 20% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 0% | 1% | 0% | 2% | 0% | 3% |
| | Fossil - efficient | 0% | | 0% | | 0% | |
| | Electric | 0% | | 0% | | 0% | |
| | Solar water heaters | 100% | | 100% | | 100% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 0% | 1% | 0% | 2% | 0% | 3% |
| | Mechanical ventilation w heat recovery 50% | 0% | | 0% | | 0% | |
| | Mechanical ventilation w heat recovery 90% | 100% | | 100% | | 100% | |
| Space cooling technologies | AC or Chillers COP > 4 | ++ | 1% | ++ | 2% | ++ | 3% |
| Windows | | ++ | 1% | ++ | 2% | ++ | 3% |
| Infiltration rate | | ++ | 1% | ++ | 2% | ++ | 3% |
| Insulation Thickness | Facade | ++ | 1% | ++ | 2% | ++ | 3% |
| | Rooftop | ++ | 1% | ++ | 2% | ++ | 3% |
| | Ground | ++ | 1% | ++ | 2% | ++ | 3% |
| Shadowing measures (window shading) | | ++ | 1% | ++ | 2% | ++ | 3% |

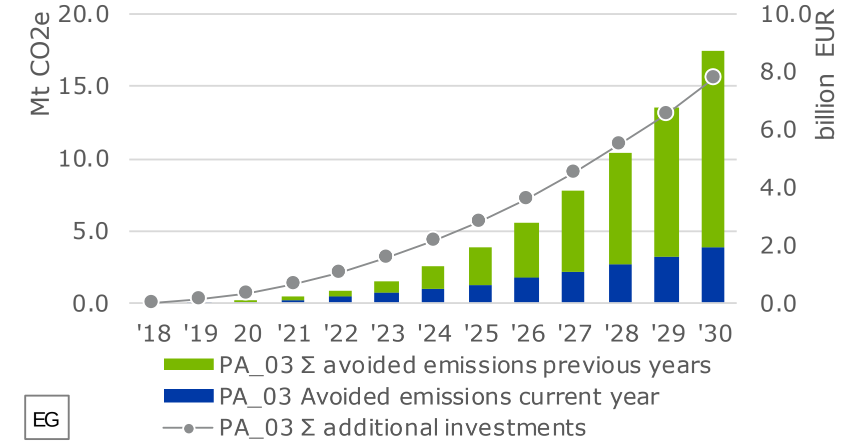
# A.14 EGY_PA_03: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

## Total (left) and specific (right) final energy demand per year



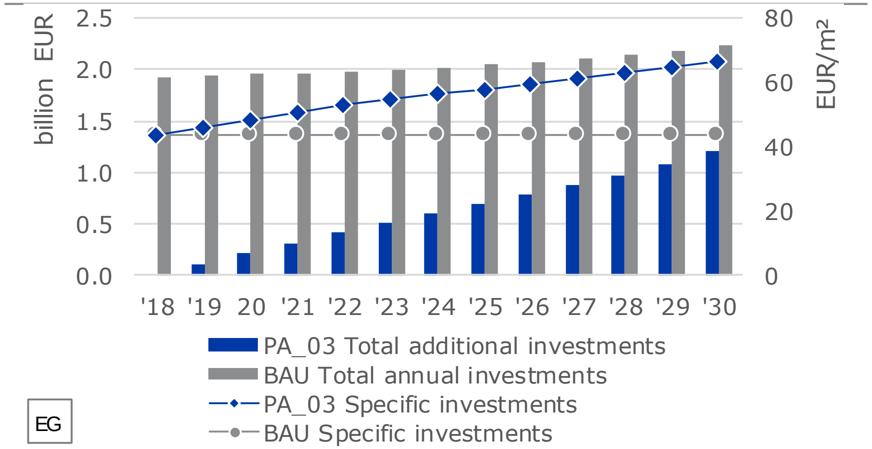

• **Energy demand of new constructions can be reduced by ~40% until 2030**

## Accumulated avoided emissions (left) and additional accumulated investments (right)



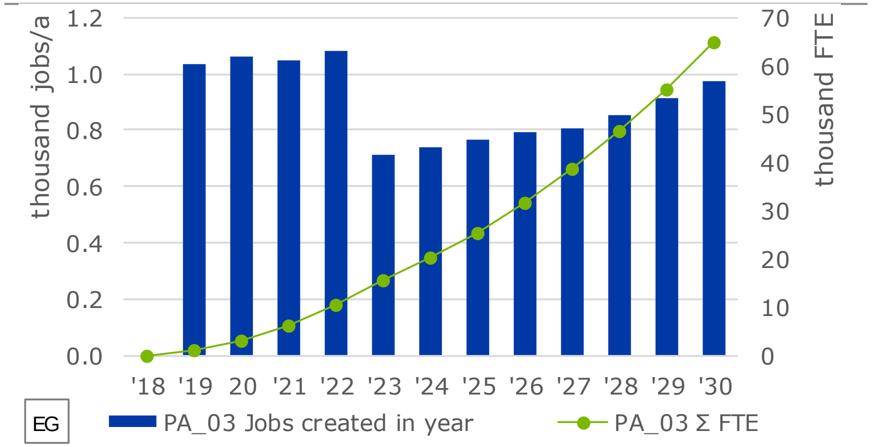

• **~3,810 ktCO2e can be mitigated by 2030**

## Total (left) and specific (right) investments per year




• **Average additional investment costs between 2019-2030 are ~13 EUR/m² new building floor space**

## Newly created jobs per year (left) and accumulated FTE (right)




• **~10,775 jobs can be created until 2030**

**ANNEX_EGY_PA_3: Assumed future technology distribution and affected shares**

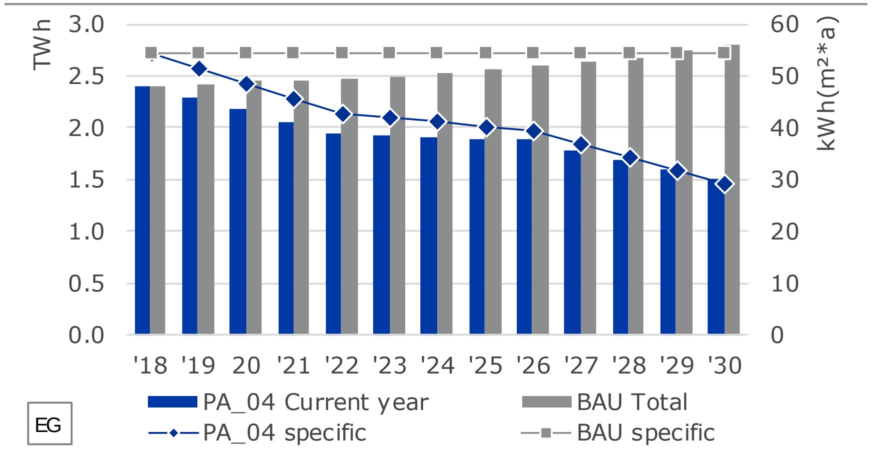
| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 0% | 8% | 0% | 15% | 0% | 20% |
| | Gas boilers - condensing | 30% | | 30% | | 30% | |
| | Direct electricity | 30% | | 30% | | 30% | |
| | Heat Pumps (any source) - COP 3 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 20% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 20% | | 20% | | 20% | |
| | Solar water heaters | 0% | | 0% | | 0% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 0% | 24% | 0% | 30% | 0% | 30% |
| | Fossil - efficient | 33% | | 33% | | 33% | |
| | Electric | 33% | | 33% | | 33% | |
| | Solar water heaters | 34% | | 34% | | 34% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 35% | 20% | 35% | 30% | 35% | 40% |
| | Mechanical ventilation w heat recovery 50% | 35% | | 35% | | 35% | |
| | Mechanical ventilation w heat recovery 90% | 30% | | 30% | | 30% | |
| Space cooling technologies | AC or Chillers COP > 4 | o | 40% | + | 60% | ++ | 70% |
| Windows | | + | 20% | + | 37.5% | + | 56.25% |
| Infiltration rate | | + | 8% | + | 20% | + | 30% |
| Insulation Thickness | Facade | + | 16% | + | 40% | + | 60% |
| | Rooftop | + | 56% | + | 77% | + | 84.7% |
| | Ground | + | 56% | + | 77% | + | 84.7% |
| Shadowing measures (window shading) | | + | 16% | + | 30% | + | 40% |

Supported by:

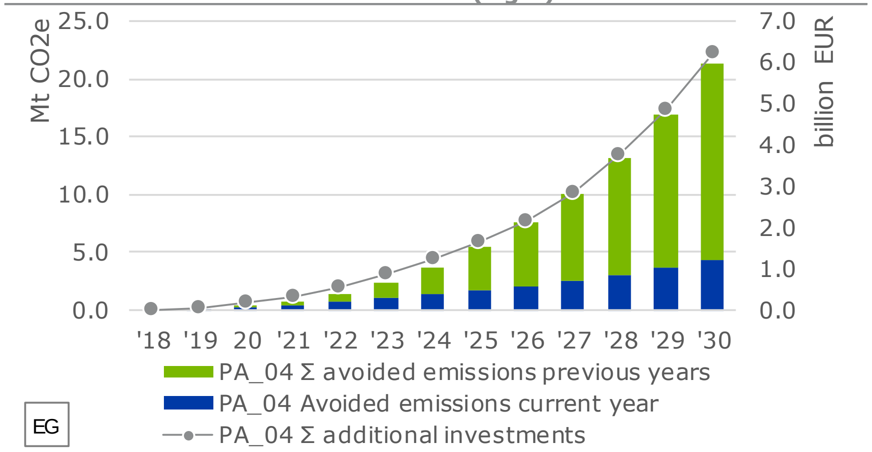
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

INTERNATIONALE KLIMASCHUTZINITIATIVE (IKI)

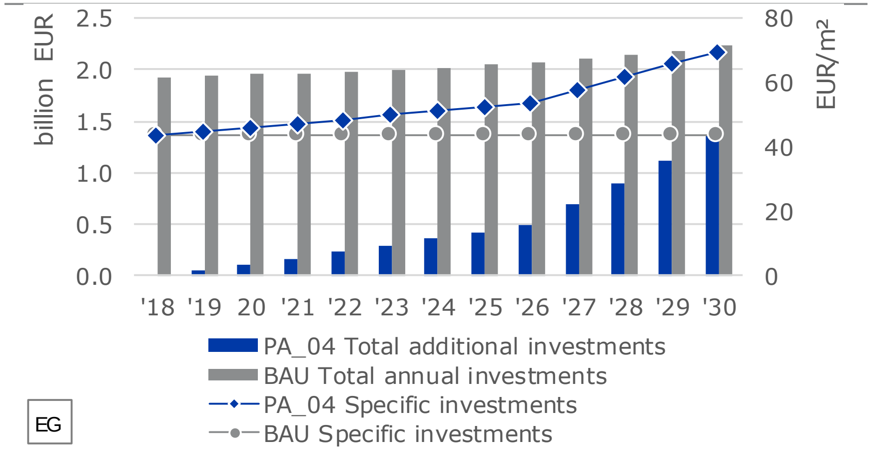
# A.15 EGY_PA_04: Impacts on energy demand, avoided emissions, investments and jobs of policy measure



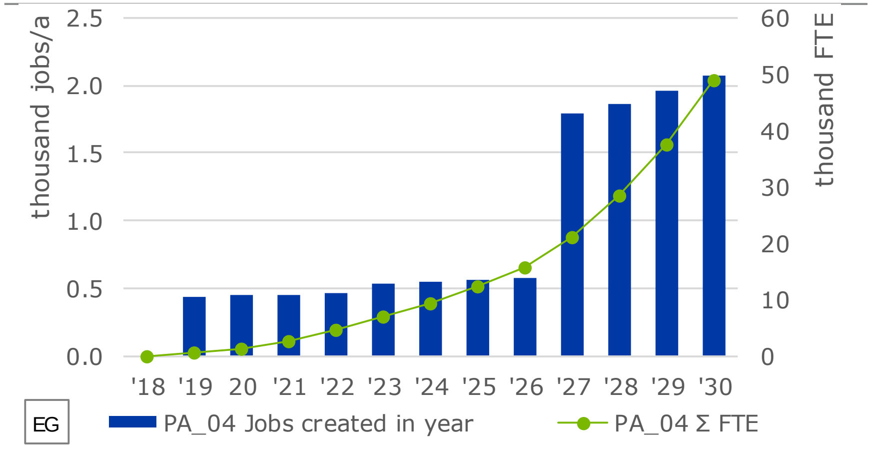

• **Energy demand of new constructions can be reduced by ~46% until 2030**




• **~4,400 ktCO2e can be mitigated by 2030**




• **Average additional investment costs between 2019-2030 are ~11 EUR/m² new building floor space**



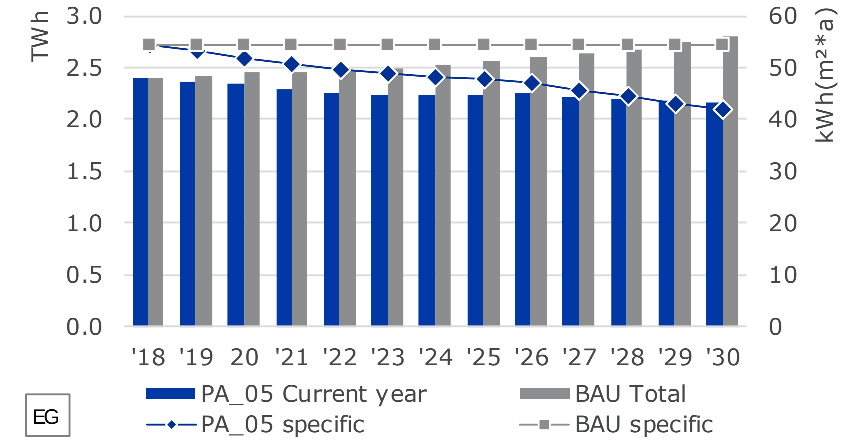

• **~11,696 jobs can be created until 2030**

**ANNEX_EGY_PA_04: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 10% | 10% | 5% | 15% | 0% | 20% |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 10% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 35% | 30% | 15% | 30% | 0% | 30% |
| | Fossil - efficient | 10% | | 25% | | 35% | |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | 25% | 75% | 30% | 60% | 40% |
| | Mechanical ventilation w heat recovery 50% | 7% | | 15% | | 20% | |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | + | 50% | + | 60% | ++ | 70% |
| Windows | | + | 25% | + | 37.5% | ++ | 56.25% |
| Infiltration rate | | + | 10% | + | 20% | ++ | 30% |
| Insulation Thickness | Facade | + | 20% | + | 40% | ++ | 60% |
| | Rooftop | + | 70% | + | 77% | ++ | 84.7% |
| | Ground | + | 70% | + | 77% | ++ | 84.7% |
| Shadowing measures (window shading) | | + | 20% | + | 30% | ++ | 40% |

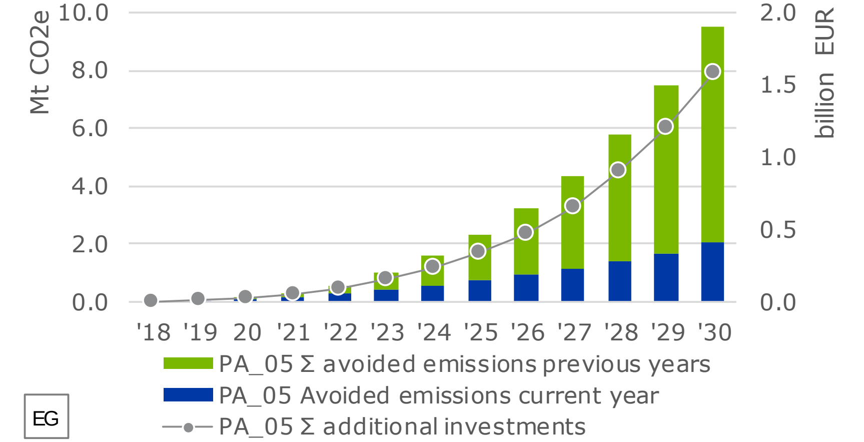
# A.16 EGY_PA_05: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

## Total (left) and specific (right) final energy demand per year



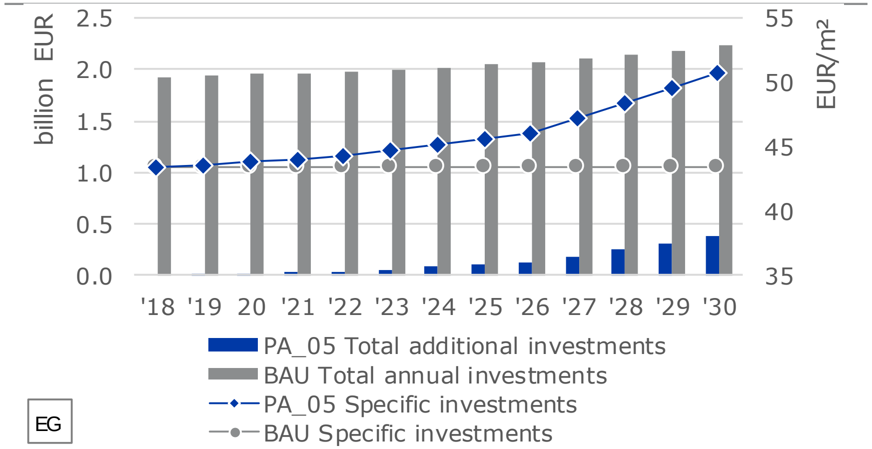

- **Energy demand of new constructions can be reduced by ~23% until 2030**

## Accumulated avoided emissions (left) and additional accumulated investments (right)



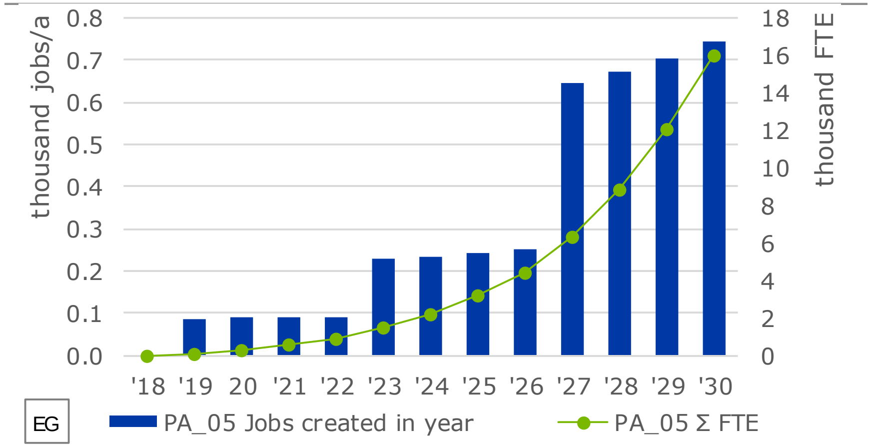

- **~2,030 ktCO2e can be mitigated by 2030**

## Total (left) and specific (right) investments per year




- **Average additional investment costs between 2019-2030 are ~3 EUR/m² new building floor space**

## Newly created jobs per year (left) and accumulated FTE (right)



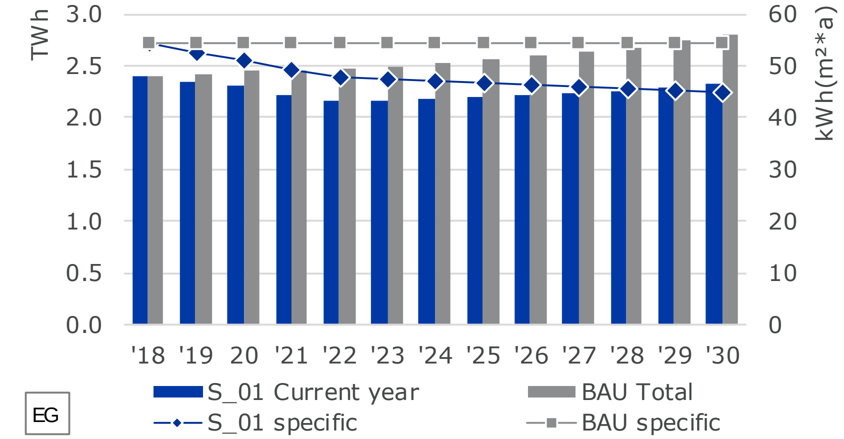

- **~4,073 jobs can be created until 2030**

**ANNEX_EGY_PA_05: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 10% | 1% | 5% | 2% | 0% | 2% |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 10% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 35% | 6% | 15% | 6% | 0% | 6% |
| | Fossil - efficient | 10% | | 25% | | 35% | |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | 10% | 75% | 12% | 60% | 16% |
| | Mechanical ventilation w heat recovery 50% | 7% | | 15% | | 20% | |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | + | 15% | + | 18% | ++ | 21% |
| Windows | | + | 5% | + | 7.5% | ++ | 11.25% |
| Infiltration rate | | o | 9% | + | 18% | ++ | 27% |
| Insulation Thickness | Facade | + | 14% | + | 28% | ++ | 42% |
| | Rooftop | + | 49% | + | 53.9% | ++ | 59.29% |
| | Ground | o | 49% | + | 53.9% | ++ | 59.29% |
| Shadowing measures (window shading) | | o | 2% | + | 3% | ++ | 4% |

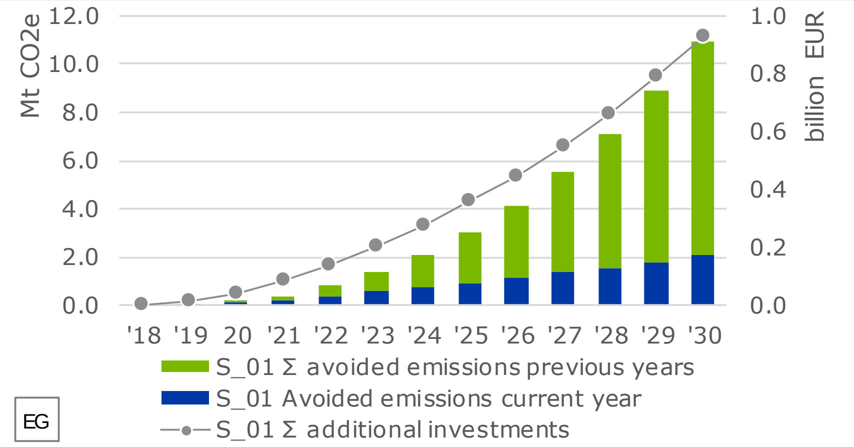
# A.17 EGY_S_01: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

Total (left) and specific (right) final energy demand per year



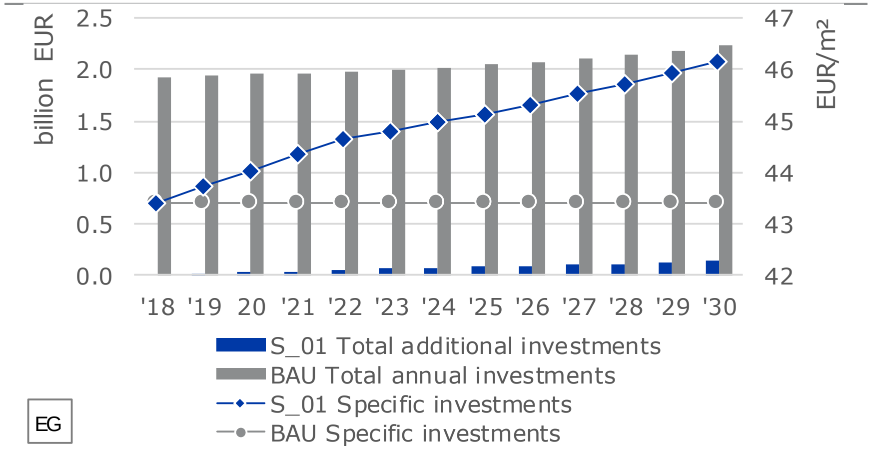

• Energy demand of new constructions can be reduced by ~17% until 2030

Accumulated avoided emissions (left) and additional accumulated investments (right)



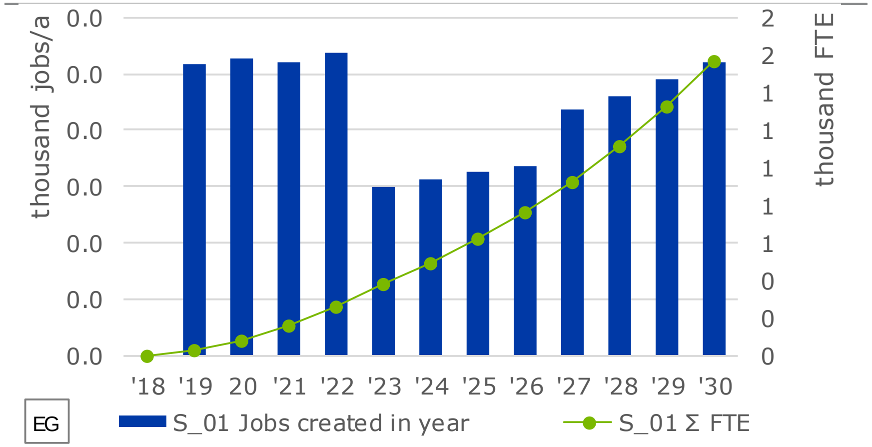

• ~2,050 ktCO2e can be mitigated by 2030

Total (left) and specific (right) investments per year




• Average additional investment costs between 2019-2030 are ~2 EUR/m² new building floor space

Newly created jobs per year (left) and accumulated FTE (right)




• ~264 jobs can be created until 2030

**ANNEX_EGY_S_01: Assumed future technology distribution and affected shares**

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 0% | 0% | | 0% | | 0% |
| | Gas boilers - condensing | 0% | | 0% | | 0% | |
| | Direct electricity | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 3 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 0% | | 0% | | 0% | |
| | Heat Pumps (any source) - COP 5 | 0% | | 0% | | 0% | |
| | Solar water heaters | 0% | | 0% | | 0% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 0% | 0% | 0% | 0% | 0% | 0% |
| | Fossil - efficient | 0% | | 0% | | 0% | |
| | Electric | 0% | | 0% | | 0% | |
| | Solar water heaters | 0% | | 0% | | 0% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 0% | 0% | 0% | 0% | 0% | 0% |
| | Mechanical ventilation w heat recovery 50% | 0% | | 0% | | 0% | |
| | Mechanical ventilation w heat recovery 90% | 0% | | 0% | | 0% | |
| Space cooling technologies | AC or Chillers COP > 4 | ++ | 50% | ++ | 60% | ++ | 70% |
| Windows | | o | 0% | o | 0% | o | 0% |
| Infiltration rate | | o | 0% | o | 0% | o | 0% |
| Insulation Thickness | Facade | o | 0% | o | 0% | o | 0% |
| | Rooftop | o | 0% | o | 0% | o | 0% |
| | Ground | o | 0% | o | 0% | o | 0% |
| Shadowing measures (window shading) | | o | 0% | o | 0% | o | 0% |

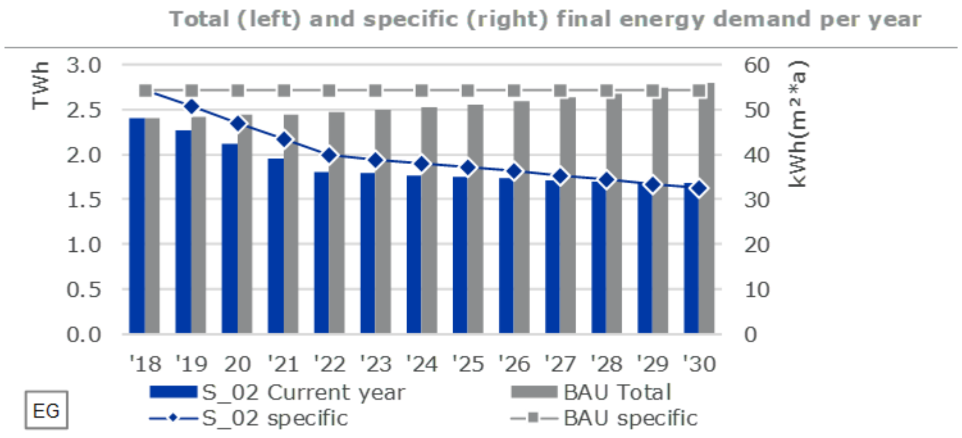
Supported by:

NAVIGANT
A Guidehouse Company

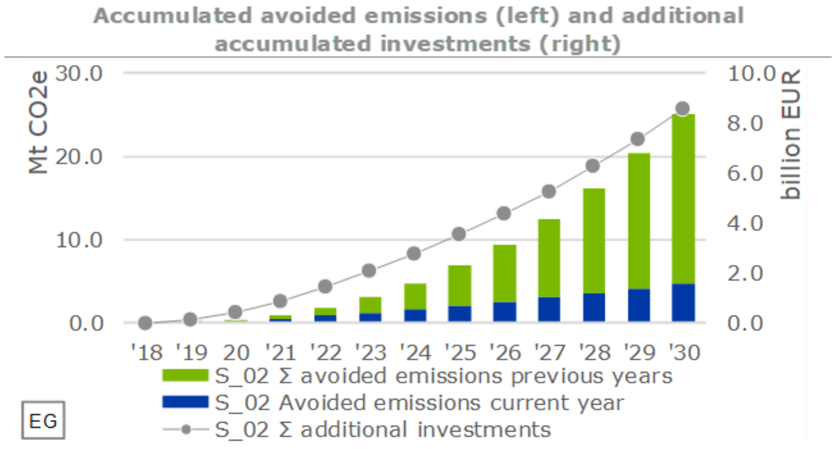
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

INTERNATIONALE KLIMASCHUTZINITIATIVE (IKI)

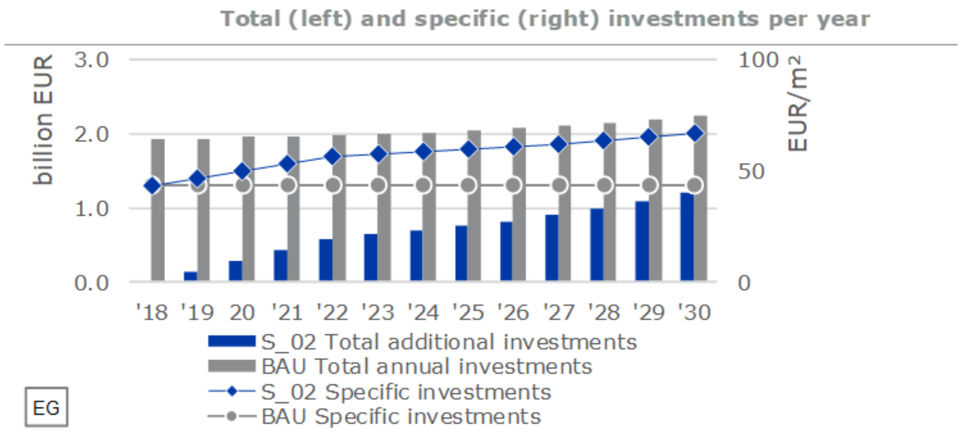
# A.18 EGY_S_02: Impacts on energy demand, avoided emissions, investments and jobs of policy measure



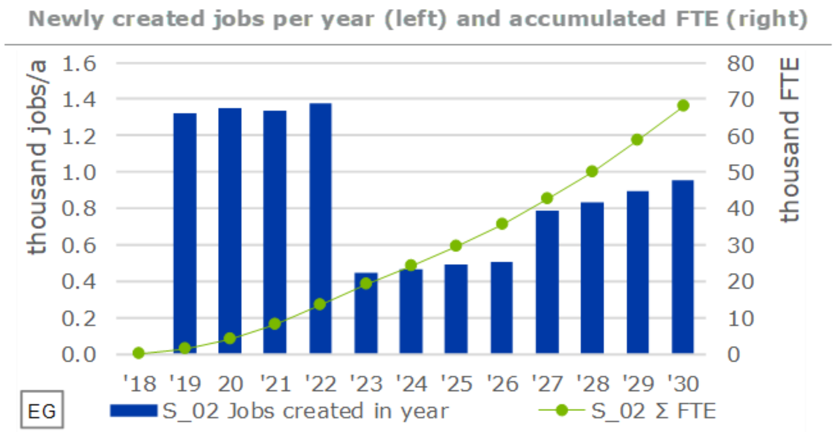

• Energy demand of new constructions can be reduced by ~40% until 2030




• ~4,770 ktCO2e can be mitigated by 2030




• Average additional investment costs between 2019-2030 are ~15 EUR/m² new building floor space




• ~10,775 jobs can be created until 2030

## ANNEX_EGY_S_02: Assumed future technology distribution and affected shares

| Technologies | | 2019-2022 | | 2023-2026 | | 2027-2030 | |
|---|---|---|---|---|---|---|---|
| | | Target distribution | Affected shares | Target distribution | Affected shares | Target distribution | Affected shares |
| Space heating technologies | Gas boilers - conventional | 10% | 8% | 5% | 12% | 0% | 16% |
| | Gas boilers - condensing | 15% | | 20% | | 25% | |
| | Direct electricity | 50% | | 35% | | 15% | |
| | Heat Pumps (any source) - COP 3 | 10% | | 5% | | 0% | |
| | Heat Pumps (any source) - COP 4 | 10% | | 20% | | 20% | |
| | Heat Pumps (any source) - COP 5 | 5% | | 10% | | 30% | |
| | Solar water heaters | 0% | | 5% | | 10% | |
| | Biomass boilers - conventional | 0% | | 0% | | 0% | |
| | Biomass boilers - efficient | 0% | | 0% | | 0% | |
| Water heating technologies | Fossil - conventional | 35% | 24% | 15% | 24% | 0% | 24% |
| | Fossil - efficient | 10% | | 25% | | 35% | |
| | Electric | 40% | | 30% | | 15% | |
| | Solar water heaters | 15% | | 30% | | 50% | |
| Mechanical Ventilation | Natural ventilation (windows) or mechanical ventilation w/o heat recovery | 90% | 0% | 75% | 0% | 60% | 0% |
| | Mechanical ventilation w heat recovery 50% | 7% | | 15% | | 20% | |
| | Mechanical ventilation w heat recovery 90% | 3% | | 10% | | 20% | |
| Space cooling technologies | AC or Chillers COP > 4 | ++ | 40% | ++ | 48% | ++ | 56% |
| Windows | | o | 0% | o | 0% | o | 0% |
| Infiltration rate | | o | 0% | o | 0% | o | 0% |
| Insulation Thickness | Facade | o | 0% | o | 0% | o | 0% |
| | Rooftop | o | 0% | o | 0% | o | 0% |
| | Ground | o | 0% | o | 0% | o | 0% |
| Shadowing measures (window shading) | | o | 0% | o | 0% | o | 0% |

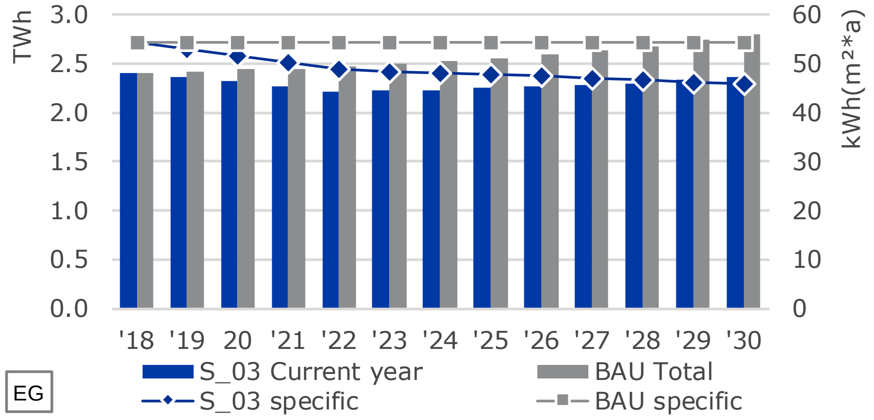
Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

INTERNATIONALE KLIMASCHUTZINITIATIVE (IKI)

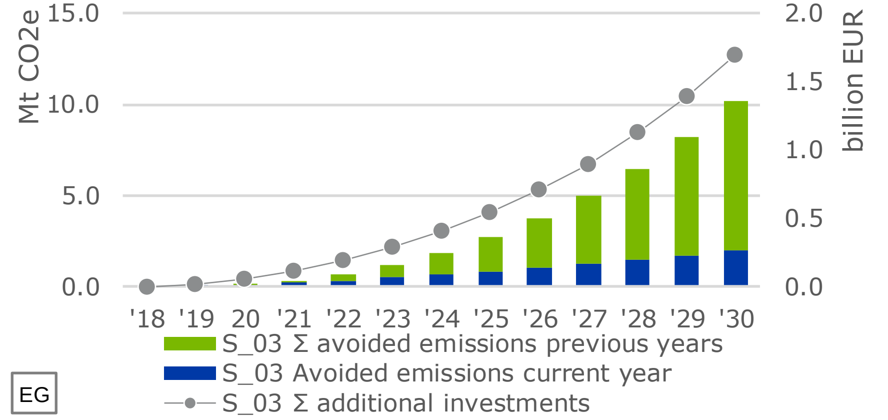
# A.19 EGY_S_03: Impacts on energy demand, avoided emissions, investments and jobs of policy measure

### Total (left) and specific (right) final energy demand per year



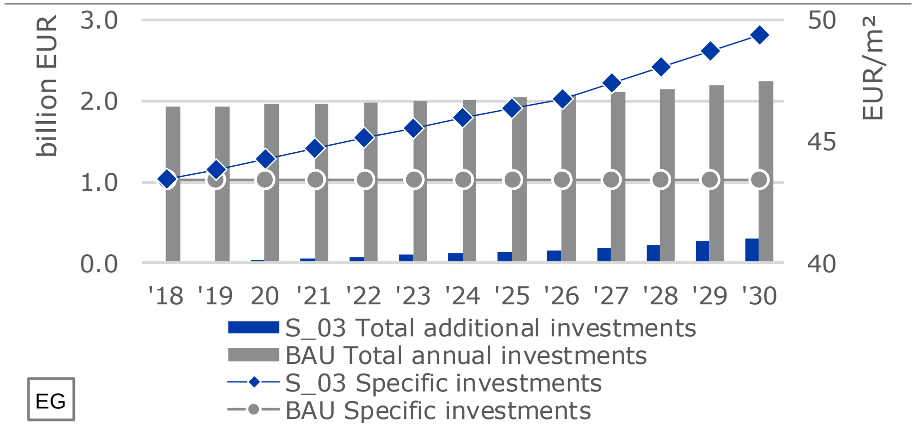

- **Energy demand of new constructions can be reduced by ~16% until 2030**

### Accumulated avoided emissions (left) and additional accumulated investments (right)



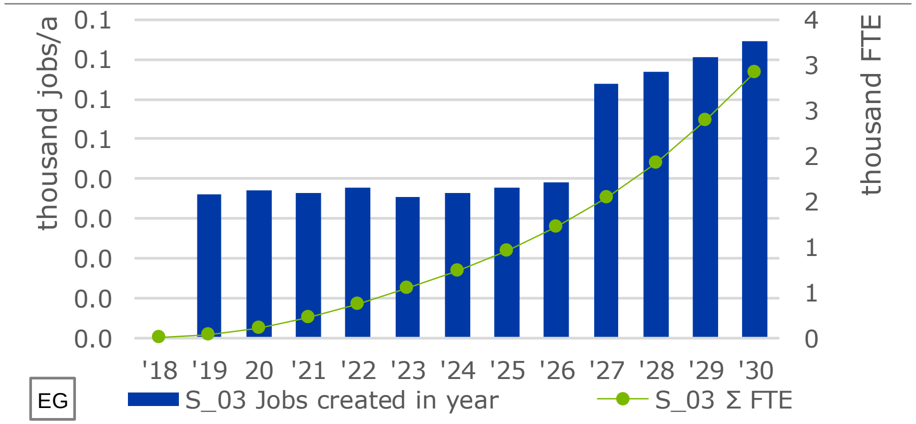

- **~1,980 ktCO2e can be mitigated by 2030**

### Total (left) and specific (right) investments per year




- **Average additional investment costs between 2019-2030 are ~3 EUR/m² new building floor space**

### Newly created jobs per year (left) and accumulated FTE (right)




- **~572 jobs can be created until 2030**